Eng. Lib.   APR 20 1908

SCIENTIFIC AMERICAN SUPPLEMENT. No. 1685

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Copyright, 1908, by Munn & Co.

Published weekly by Munn & Co. at 361 Broadway, New York.

Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York

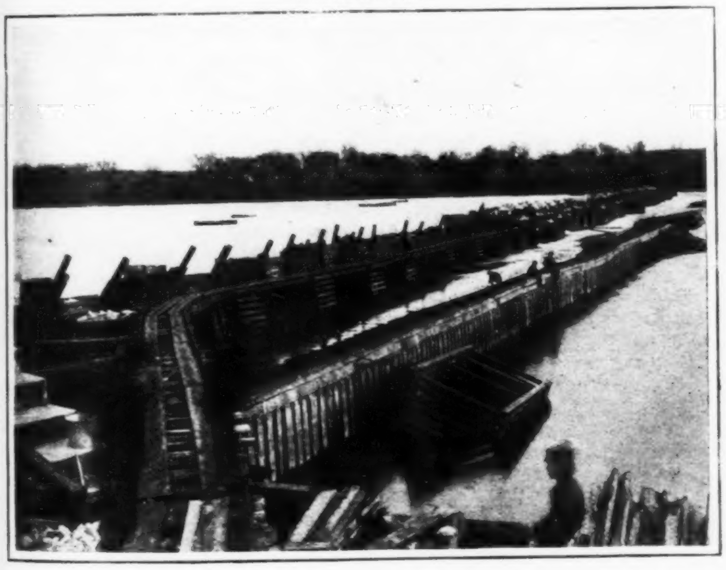
Scientific American, established 1845.
Scientific American Supplement, Vol. LXV., No. 1685.

NEW YORK, APRIL 18, 1908.

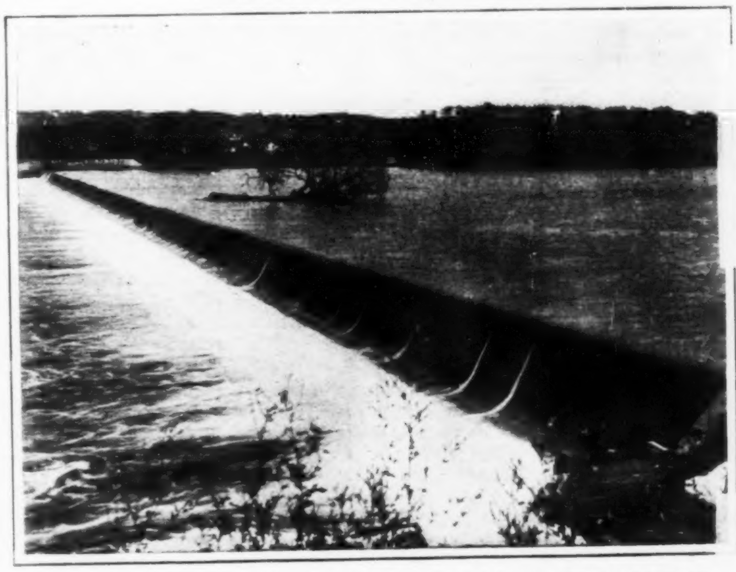
Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a ye

END OF ONE SECTION WITH CONCRETE COMPLETE, SHOWING UNION WITH FENDER DAM.

VIEW FROM SOUTH SIDE LOOKING NORTHWEST, SHOWING FENDER OR UPPER DAM COMPLETE WITH RAILS IN PLACE.



VIEW FROM NORTH LOOKING SOUTHEAST, SHOWING COFFERDAM AND CONSTRUCTION RAILWAY WITH PORTIONS OF OLD DAM BELOW.



VIEW OF FINISHED DAM FROM SOUTH SIDE, SHOWING WEST AND EAST HEAD-GATES.

VIEW FROM SOUTH SIDE LOOKING NORTHEAST, SHOWING COMPLETED CONCRETE AND CRIBS OF COFFERDAM.

THE MOST DIFFICULT PART OF THE COFFERDAM CONSTRUCTION IN 12 FEET OF WATER: STAY CRIB AT RIGHT HAS BEEN MOVED DOWN-STREAM BY CURRENT.

THE MARSEILLES CONCRETE DAM.

THE MARSEILLES CONCRETE DAM.

A DIFFICULT ENGINEERING FEAT.

BY DR. J. H. GOODELL.

THE south end of Lake Michigan is in a large depression. From 20 to 40 miles in all directions from the shore of the lake there is a ridge, beyond which the drainage of the rivers flows into the Mississippi. The Kankakee River rises east of this ridge in southwestern Michigan and flows nearly south. Through northwestern Indiana it bends west, and in northwestern Illinois it runs in a northwesterly direction to join the Desplaines nine miles east of Morris, Ill. The latter river rises in southeast Wisconsin, west of the ridge spoken of above, and flows nearly south to join the Kankakee. The watershed of these rivers furnishes an approximate volume of 25,000 cubic feet per minute flowing past a given point, but the variation is so great that it can only be estimated by approximation. The Illinois River is formed by the junction of the Kankakee and Desplaines, that unite nine miles east of Morris, Ill. The Chicago Drainage Canal draws its water from Lake Michigan and discharges into the Desplaines River.

The large volume of water from the Drainage Canal with the watershed water from the Kankakee and Desplaines afford very desirable water powers down the Illinois where the fall is sufficient for an adequate head. There are very few rapids on this river, the one at Marseilles being perhaps the largest. The fall here, from Kickapoo Creek above the dam to Bell Island below, a distance of three miles, is 20 feet, the dam being nearly in the center. Ever since 1832 there has been some kind of improvement of the water power. The dam that went out in the winter of 1902-3 was constructed in 1868. Up to its time, it was the most pretentious affair of its kind. It was of cob-house form, the space between the logs being filled with stone.

At this point the river is 960 feet wide. The average depth of the water at the time of the erection of the present concrete dam was eight feet, with a velocity of from six to ten miles per hour. The average flow of water over the dam cannot be given with accuracy. In exceeding high water it is often 1,500,000 cubic feet a minute, or more. It is perhaps better to take the flow in a very dry season, when the river would naturally be very low. This occurs every eight or ten years. We have data to show the number of cubic feet from the Sanitary Canal as follows: From the Bridgeport pumps, 35,000 cubic feet; with the watershed water, about 25,000 cubic feet; and with the new pumps in Chicago, nearly ready for service, there will be not far from 500,000 cubic feet per minute going over the dam. To be acceptable to the Illinois Valley people, the law under which the Sanitary District of Chicago was established was made to provide for the passage down the canal of 600,000 cubic feet per minute to afford the requisite dilution to the sewage. Through the rock cut of the Sanitary District Canal, the channel is constructed to pass 720,000 cubic feet per minute with a velocity not to exceed three miles per hour. In former years, before the coming of the drainage water, a dry season would reduce the flow so much that the mills at Marseilles would often have to suspend operations, it being even possible to cross the river dry shod.

The old cob-house dam went out during the high water in the winter of 1902-3. Portions of it are shown in the photographs. The hardest part of the work in the new construction was the building of the coffer-dam. Cribs of 6 x 12 timbers, 12 feet square, and when completed 12 feet high, were partially loaded with stone and launched upstream far enough to float down and land about 200 feet above the proposed site of the dam, where they were filled by boats with stone sufficient to weigh them down onto the bed of the river. Generally speaking, the bed of the river is clay-slate and quite smooth, but very slippery, as all clays are under water. These stay-cribs, as they were called, were located with some difficulty, owing to the strength of the current and the distance from the shore. Each crib was held by lines reaching to both shores of the river, and steered from a predetermined place. From these stay-cribs, the cribs of the coffer-dam were located, being constructed in the same manner as the others, except that the upper half of each crib was built up higher, to permit a railroad to be constructed at their lower end to transport the material of the dam to place. The same method of loading and launching was observed with the coffer-dam cribs as with the stay-cribs, only the lines ran from the stay-cribs instead of from the shore. The first crib of the coffer-dam was placed at the north shore, and another one ten feet from it. The railroad was then constructed upon these, and as fast as a crib was located, it was filled with stone by the dump cars. On the upstream faces of the cribs, 12 x 12 timbers were put in, one at the bottom, the other at the top, across the space between the cribs, and two-inch plank put in vertically along the timbers on their upstream side. Cinders from the mills were used as filling, the swelling of the planks stopping most of the leaks; but one of the cribs moved from its position, which was due to a bowlder in the river bed. No sheet piling could be used except as spoken of above, because of the rock bottom.

As before spoken of, the river bed is of soapstone or clay-slate, that overlies the coal measures in this part of Illinois. It is a soft, friable rock, easily breaking down on exposure, but reasonably firm under water. Two trenches, three feet wide and three feet deep, were cut in the soapstone transversely across the river, one at the downstream end of the concrete portion of the dam, the other at the upstream end. By this means there was raised up, so to speak, in the center of the concrete an anchor of rock, besides the lower edge down in the rock to hold the concrete from moving down stream. In other words, the concrete has two holds upon the rock bottom in place of one. The forms for the concrete were then erected over these trenches, and the fender dam, to be described presently, erected. When the cement was put in from the dump cars seen in the photographs, the fender dam was in place to receive its portion. All the concrete was machine-mixed in the north shore, and carried to place by the little railroad. A spur track from the Rock Island Railroad delivered all materials just at the place of mixing and using, to save handling. The specifications permitted 25 per cent of stone to be added to the cement while green. The dam was constructed in sections varying in length from 50 to 100 feet; each section dovetailed into its fellows on either side. The sections were also secured to each other by the timbers in the fender dam. In one of the views, the concreted portion and fender dam are shown partially in section, except the anchor trenches. While the excavation of the trenches was going on, the fender dam was being constructed, its downstream side forming a part of the form for the concrete. The timbers for this section were 4 x 6 hemlock, laid up in cob-house form, with an up-stream slope of 25 per cent from the rounded comb of the completed structure. Holes were drilled down through the two last courses of timbers at the upstream side when in place, and two-inch iron rods driven down into the rock for two feet, where they were cemented fast. As will be seen from the view, the spaces between the timbers were filled with limestone, carefully driven in to make it solid. Four-inch oak plank decking was spiked down onto the timbers, and 60-pound rails securely fastened to the decking. These rails were bent over to accommodate the rounded portion of the comb of the dam. The cement forms being then complete, the concrete was filled in. Necessarily, some of it ran between the stone and timbers, and joined the concrete to the fender dam. The timbers of the latter broke joints at the intersections, that is, they ran over into their fellows on either side, insuring the safety of the structure at the joints. The railroad rails were bedded down into the cement at the comb of the dam, and for 150 feet from the controlling works at the north end were five feet apart, the rest of the way ten feet apart. The object of these rails is to protect the dam from the ice and driftwood. The drawing of the water through the head gates makes a large amount of ice near the north shore; consequently the rails were placed closer together here than for the rest of the dam.

The old dam was protected on the downstream side by a 45-degree apron, but large holes were gouged out of the soapstone below the dam by the action of the water and ice. It was believed that this was very much greater than ordinary during the high water of 1902 and 1903, undermining the old dam so much that it went out. In the new structure the downstream end of the concrete portion is elevated in a graceful curve, the water in flowing over being thrown upward a little and broken up before it leaves the dam. This is well seen in the photograph of the completed dam. The white appearance of the water indicates its breaking up. This form of construction was used to prevent the gouging action of the water upon the soapstone. It has stood the action of the ice and water for four years, and practically seems to be as good as when put in. The experience of two winters of very severe ice has not impaired it, no gouging action below the dam being apparent. It is also very efficient in breaking up the ice that goes over the dam.

The dam is 960 feet long, 12 feet high, 9 feet above the bed of the river, the concrete portion being 12 feet wide at the base. The fender dam reaches 20 feet upstream, the entire structure being from upstream to downstream side, 32 feet. There was of the concrete 2,850 cubic yards, which cost $4.50 per cubic yard in place. The dam and its approaches cost $30,000. When the cribs of the coffer-dam were taken away, the stone was left to protect the upper edge of the fender dam. The writer is indebted to W. D. Boyce, president of the Marseilles Land and Water Power Company, for information in the preparation of this article.

THE FIREMAN AT THE FURNACE.*

By D. T. RANDALL.

THE skill of the fireman is the most important element in connection with furnace equipment. As a matter of fact, the personal element is the greatest hindrance to progress in the abatement of smoke. Both the owner and the fireman must be interested to obtain the best results. Intelligent supervision in the boiler room to secure proper air admission and care in firing will result in the saving of the losses due to smoke or unconsumed gases and to heating an excessive amount of air. At many plants such supervision has reduced the coal bills by 5 to 20 per cent, depending on the coal and the methods formerly in use.

It is a generally conceded fact that intelligent men trained in boiler-room practice could save 10 per cent of the fuel used in 50 per cent of the plants of the United States, and that in another 25 per cent of the plants such men could save 5 per cent of the fuel. It is the practice of nearly all large power plants to employ a boiler-room expert, and many of them have chemists who make frequent tests and investigations to determine the conditions favorable to the best economy. The saving of only a small percentage of the coal consumed will make a handsome return for the cost of the experimental work. There are now in a few of our larger cities competent engineers who are making a specialty of supervising boiler plants for a number of firms.

A few examples of carelessness and indifference on the part of firemen will in a measure explain why many persons are skeptical regarding the value of mechanical stokers and other smoke-preventing devices.

At a plant which had a smoke-preventing device, but which was smoking, the fireman said a connecting chain had been broken for several days and he "didn't have time to bother with it." It would not have required more than ten minutes to join the two ends with wire for a temporary repair. In another plant the fireman said: "The thing takes too much steam, and I shut it off." Many other cases of willful neglect have been observed.

Very few firemen can be induced to fire regularly and frequently, because it is easier to put in enough coal to last twenty or thirty minutes at one time and have little or nothing to do in the interval between firings. In one instance the engineer took occasion to measure the draft between the grates before and after firing on a down-draft furnace which had a good draft. The draft before firing was 0.35 inch of water, but after the fireman had thrown on sixty-three shovelfuls of coal the flow of air was so seriously retarded that the draft increased to 0.62 inch. Great volumes of smoke were given off, indicating this lack of air.

Prof. Benjamin, speaking of steam and air jets, expresses himself as follows: "It is a very effective method of smoke prevention, and is used very largely in Cleveland; but it depends so much upon the individuality of the engineer and fireman. I have found that men who use that means had to be watched so continually and reprimanded so much that I got out of patience with that sort of prevention."

Difficulties are also encountered with stokers. One of the greatest troubles is the tendency of the fireman to poke the fires unnecessarily instead of using or adjusting the attachments provided for feeding and handling the coal. In many plants where it is possible they will shovel green coal into the stokers, instead of feeding it through the hopper, and then take a bar and stir up the fresh coal with the coke and ashes, causing smoke and wasting the coal.

It is not an uncommon experience that on inspection the boiler tubes are found to be covered with scale on one side and soot on the other. One plant with

* Abstract from a Bulletin issued by the United States Geological Survey.

nearly 4,000 horse-power had soot hanging from the surfaces of the tubes, and on inquiry it developed that these tubes had not been cleaned for a period of four months, no cleaning having been done since the new master mechanic had taken charge.

These examples emphasize the facts that the management of the boiler room is a problem for properly trained men and that as the coal burned is a considerable item of expense, averaging about 50 per cent of the cost of producing power, there is more opportunity to save in the boiler room than in the engine room with any given equipment. The average boiler room is a hot, dirty, and otherwise unattractive place. For these reasons but little attention has been paid to it by superintendents and operating engineers in moderate-sized plants. The boiler rooms are managed for the most part by men hired not so much for what they know as for their ability to do hard work, and they get comparatively small wages. There are, however, some mechanical appliances, such as the chain grate, which leave but little to the skill of the fireman.

THE CAUSES OF "KNOCKING."*

A GAS ENGINE PROBLEM AND ITS SOLUTION.

THERE is probably no trouble prone to develop in the engine which is so difficult to locate and remedy as a bad and persistent knock. Every motorist of experience knows that he can make the engine knock by advancing the ignition beyond the normal working point for a given number of revolutions, and he also knows that he can advance the ignition more when the engine is running fast than when it is running slow without knocking occurring. Advanced ignition, even a very slight advance with engine moving infinitely slow, as at starting, results in a back fire, and the knock is not so much heard as "felt." The effect may be illustrated in this way: Imagine a billiard ball supported by a cord and swinging like a pendulum from a support. The ball is allowed to reach the end of its swing, or very nearly so, and if at that instant one gives it a forward push or impulse with the closed fist so that the backward swing is *followed* up slightly the swing of the pendulum will be accelerated. Substitute for the pendulum ball the rising piston in the cylinder and for the closed fist the exploding charge, and we get a fairly close analogy of correctly timed ignition with no knocking. Suppose, now, one meets the oncoming pendulum half way, or nearly so, across the swing. The forward motion will be suddenly checked and the experimenter will get a smart rap on the knuckles; he will, in fact, feel the "knock." Apply the former analogy and we have the case of advancing the spark too much. To imitate a back-fire at starting one might substitute for the billiard ball a heavy weight, give it a good swing, and meet it less than half way with a sharp blow from the fist. The result would probably be either a badly sprained or broken wrist. Too advanced ignition is not quite the same thing as pre-ignition, which likewise can cause severe knocking; but this condition must also not be confused with self-ignition, although both may occur nearly simultaneously. Faulty carburetion or carbon deposit on the piston may cause pre-ignition as generally understood. Strictly, a pre-ignition is a too-advanced ignition occurring without the agency of the spark. On the other hand, self-ignition resulting from the same cause may, and often does, occur at approximately the correct time if the engine be running on about half-throttle. A not uncommon experience is to find that on switching off the spark and cutting off most of the gas the engine fires with perfect regularity for some hundreds of yards, but finally misfires and stops. If the throttle be opened full while the engine is thus running it generally results in a severe knock taking place. It is easy to follow why this is; more gas means higher compression, and the greater heat induced raises the ignition media to the critical point of incandescence earlier in the stroke. The trouble may still occur even after the combustion chamber and the top of the piston have been well scraped from carbon deposit. This is where the real difficulty begins, and one can only advance theories as against practical conclusion.

Suppose a pair of plugs are fitted in each cylinder and one is mounted over the exhaust valve and the other in the neighborhood of the inlet, it will follow that the electrodes—sparking points—of the former will be maintained at a higher temperature than the latter, and, furthermore, there will be a tendency for exhaust gas flame to lodge inside the bore of the plug, although the particular design of the plug may modify this. For instance, a plug with a deeply recessed insulator would be worse in this respect than one with a shallower insulator. The retention of a small quantity of the flaming gas would, it is reasonable to assume, cause a pre-ignition so soon as the compressed charge is urged into contact with it. In this case the result will be the same whichever plug is in action, and the only remedy is to change the plug over the exhaust valve for another pattern, preferably one with heavier electrodes and a solid insulator. In certain instances, however, the auxiliary plug over the exhaust had to be removed altogether and a twin plug used over the inlet. We have now to consider another source of the trouble, one which arises from a very small fault in the cylinder casting in the shape of a minute fin or projecting bit of metal, or a "wire edge" at one of the valve ports. The result is that the bit of superfluous metal reaches the incandescent stage under certain conditions, on the principle that a piece of fine steel wire held in a gas flame will become white hot and melt, while a stouter piece of wire would only reach a dull red heat. This is about the normal condition of the valve heads, a temperature too low to ignite the charge. The combustion chamber and cylinder walls are at a still lower temperature, estimated at 250 to 300 deg. Centigrade. The valves are very rarely nowadays the cause of any pre-ignition trouble, but at one time a form of valve head was in vogue which was prone to overheat. This had a projection in the center of the head which was slotted to take a screw-driver for grinding-in purposes.

We now come to purely mechanical causes of the trouble. The gasoline engine, being of the intermittent torque class of prime mover, requires all moving parts to be as close a working fit as possible to insure smooth running. Any undue wear or backlash in the bearings, or any inaccuracy in the alignment between two moving parts, setting up intermittent stresses, will cause the trouble, but it is not generally so marked, or likely to have such serious consequences as the knock resulting from pre-ignition and faulty timing. It is quite easy for a practised ear to distinguish between the two kinds of knocks. An engine with loose bearings may, if need be, be run for a considerable time without anything serious resulting, but it can not be regarded as good practice to allow the bearings to get into a bad state of wear. These should be taken up or adjusted as soon as it is convenient to do so; this means, of course, when the car can be spared. The true alignment of engine shaft and clutch largely depends on the bearings being in good order. Special attention should be paid to the connecting rod bearings, as there is a greater tendency for these to wear oval, taking as they do the direct thrust from the explosion and with a tendency to wear on one side.

* The Motor.

TESTS OF BRAKE SHOES.

THE wearing qualities of brake shoes have been the subject of experiment by a committee of the Master Car Builders' Association. Past tests have been confined to frictional qualities, and an attachment was fitted to the friction testing plant to permit the shoe to be brought into contact with the wheel for a predetermined interval, after which it would be automatically released, remaining in release position for another and much longer interval, during which time both wheel and shoe would return to their normal temperature. Accessory to the large machine there would be, of course, required a registering counter to show the number of applications, and a delicate balance for weighing the shoes before and after they are exposed to the action of the machine. The committee selected fifteen shoes on which frictional tests had been made in 1906 and used these shoes for the wearing tests. The machine was set under the control of a gear which required 800 revolutions for a complete cycle, during 190 of which the shoe was in contact with the wheel. It was found that by employing a speed of 20 miles per hour and a brake shoe pressure during application of 2,808 pounds the machine could be kept in continuous motion under the cycle without undue heating either of the wheel or shoe. The severity of test conditions may be judged from the fact that the work done by the brake shoe during each application is approximately the same as that which would be done by each of the eight shoes of a loaded 100,000 pounds capacity car in bringing the car to rest on a level track from a speed of 40 miles an hour. The accompanying table shows the results of these tests. In future tests the committee intends to measure the wear and tear on the wheel used in the testing, a factor not heretofore studied.

WEAR OF BRAKE SHOES ON CAST-IRON WHEELS—SPEED CONSTANT AT TWENTY MILES PER HOUR; PRESSURE OF SHOE ON WHEEL, 2,808 POUNDS; REVOLUTIONS OF WHEEL DURING APPLICATION, 190; EQUIVALENT DISTANCE RUN DURING APPLICATION, 1,641.5 FEET.

Number of Shoe.	Coefficient of Friction.	Weight of Shoe, Pounds.	Number of Applications.	Total Loss of Weight, Pounds.	Loss of Weight per Application, Pound.	1,000,000 Foot-Pounds of Work Absorbed per Application.	1,000,000 Foot-Pounds of Work Absorbed per Pound of Material Lost.
158	22.5	22.046	90	0 229	0.002544	1.096	407.2
161	21.8	21.208	94	0.644	0.006850	1.004	146.6
163	21.7	19.964	118	0.337	0.002856	1.000	350.1
172	22.8	17.180	90	0.366	0.004066	1.050	258.2
175	30.3	11.202	40	0.690	0.017250	1.395	80.8
178	20.0	18.662	90	0.364	0.004044	0.921	227.7
179	36.8	9.298	40	0.593	0.014825	1.665	114.3
183	38.7	7.846	60	0.615	0.010250	1.782	173.8
186	24.1	18.778	90	0.615	0.006833	1.110	162.5
194	26.5	22.730	90	0.198	0.002200	1.220	554.6
200	22.7	15.780	90	0.243	0.002700	1.045	387.0
205	23.5	17.610	90	1.058	0.011755	1.082	92.0
209	24.7	16.818	90	0.593	0.006588	1 137	172.0
215	20.9	16.354	90	0.320	0.003555	0.963	270.9
220	26.5	13.066	91	0.220	0.002417	1.220	504.7

PHOTO-ELECTRIC FATIGUE.

PHOTO-ELECTRIC fatigue is considered by W. Hallwachs in a recent issue of Ann. der Physik. He concludes that the causes usually considered as producing the phenomena—such as oxidation, action of light, corrosion of the surfaces—have no influence; but that the principal fatigue phenomena in free air are due to the action of ozone. The author gives a summary of the experimental facts that lead him to the conclusion that photo-electric fatigue is not the result of the influence of light or of corrosion, and that it is not due to the formation of electric double-layers. In connection with the latter subject he discusses photo-electric fatigue and contact potential. In the last portion of the paper he describes the action of ozone in connection with the phenomenon. The feeble fatigue in closed vessels may be traced to the increase of electron absorption due to the increase of the gas charge of the plates. The strong fatigue in free space may be similarly explained as caused by the action of ozone in producing absorption of electrons in the gas charge of the plates, this being due to the influence of ozone on the motion of the electrons—strong absorption of slow electrons and eventual lessening of their energy of vibration in the metal.

In a recent paper on the same subject W. F. Holman describes his observation of the photo-electric current from zinc, carefully polished and cleaned. As source of illumination an electric arc between steel electrodes in hydrogen was used. The chamber in which the zinc was mounted was evacuated and left at an indefinitely low pressure in connection with a drying chamber for several hours. With a gas pressure of 0.001 millimeter the mean value of the photo-electric current was 6×10^{-10} amperes. After admitting hydrogen at a pressure of 1.5 millimeter, a glow current was then sent from the zinc as kathode for about 15 minutes, and the chamber again evacuated to a pressure less than 0.001 millimeter. Successive readings of the photo-electric current then gave a mean value of 3.8×10^{-10} amperes. After standing 12 hours the mean value observed was 4.1×10^{-10} amperes. Then hydrogen was again admitted, and the metal used as *anode*, during a period of about 7 minutes, after which the pressure in the chamber was reduced to less than 0.001 millimeter. The mean value of the photo-electric current in this case was 5.9×10^{-10} amperes. The results may be explained if it is assumed that hydrogen serves as carrier of negative electricity in the photo-electric current as in Skinner's experiments on the glow current through rarefied gases. A similar series of experiments, using electrodes of different metals, gave the following results:

	Photo-Electric Current (10^{-10} Amps.).				
	Zinc.	Copper.	Silver.	Aluminium	Iron.
After using as kathode with glow current in hydrogen	16.0	11.6	6.4	0.6	0.6
After standing twelve hours in hydrogen..................	8.8	1.8	0.6	0.0	0.0
After again using as kathode.	41.0	16.0	14.0	5.0	4.5
After using as anode in hydrogen.	7.0	15.0	6.0	1.3	1.4
After using as kathode again.	36.0	16.5	25.0	2.7	5.0
After standing in hydrogen several hours...............	28.0	9.3	16.0	2.5	3.2

ELEMENTS OF ELECTRICAL ENGINEERING.—XV.

ALTERNATING CURRENT MOTORS. PART I.

BY A. E. WATSON, E.E., PH.D., ASSISTANT PROFESSOR OF PHYSICS IN BROWN UNIVERSITY.

Continued from Supplement No. 1683, page 214.

From the very dawn of electrical engineering, and with a prominence continually increasing, the production and transmission of power by electrical means has been an insistent, and to a high degree, a successful project. A quarter century's experience with direct currents has brought about a refinement and efficiency little short of perfection, and with the exception of the present efforts to manage higher potentials than the standard 500 volts, there seem to be no attempts at radical changes of operation or construction. Only half as long a period has elapsed since alternating currents have been successfully utilized for the same purpose. In the early days of central station building, it was a common statement and belief that alternating currents were good enough for lighting—and indeed, often the only kind that could economically be transmitted to a distance—but that for motors direct currents were indispensable. However, by great persistence and ingenuity, this handicap has been removed, and to such an extent, that even for short distances, such as for distribution throughout a single building or factory, preference is often shown for the alternating motors. Many important inventions look simple enough in retrospect, but the steps by which advancement was made may have been faltering, with scientific direction lacking and financial encouragement insecure. Happily, the opposite of the last two factors has been experienced in modern electrical engineering, with consequent rapidity and usefulness of invention.

Alternating current motors follow such a variety of constructions with corresponding peculiarities of conditions of operation that two chapters will be given to their consideration. Great enthusiasm accompanied their production—their recounting should prove a fascination.

In an earlier article it was mentioned that the direction of rotation of any direct current motor is the same irrespective of the polarity of the current. That is, if the two mains to which such a motor is attached be exchanged, the motor upon being started will rotate exactly as before. True, the polarity of field and direction of current in armature has been reversed, but the torque still acts in the same direction. As there stated, actual reversal of direction of rotation can be secured by changing either armature or field, but not both. Even if these reversals take place frequently, as would be the case if the circuit was fed with alternating currents, the continuous direction of rotation of the motor would therefore be expected. In the choice between a shunt and a series motor for an actual trial, the latter should alone be used. The reason is that the simple series motor is bad enough, but the other is so much worse as actually to disguise the essential principle. The reason is found in the higher self-induction of the shunt field. Since this factor varies with the square of the number of turns of wire, the choking effect of the fine shunt winding would be such as to prevent any but a very meager current to flow, and this would so lag behind the current in the armature—a circuit of relatively low inductance—as to forbid the production of almost any torque. With the lesser inductance from the coarser series winding the lag is considerable and objectionable, but under some conditions tolerable.

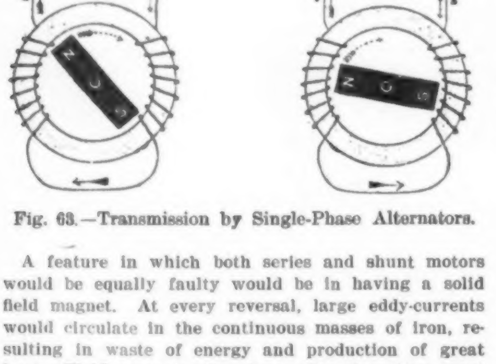


Fig. 63.—Transmission by Single-Phase Alternators.

A feature in which both series and shunt motors would be equally faulty would be in having a solid field magnet. At every reversal, large eddy-currents would circulate in the continuous masses of iron, resulting in waste of energy and production of great heat. Field magnets, therefore, of such motors must be as effectively laminated as the armatures. Of course, there is no ground, aside from that of expense, for not making all direct current motors in this manner, and, in fact, any armature that involves the use of relatively prominent teeth requires that at least the pole-tips be made of sheet iron.

Even though the iron be properly subdivided, there are other causes that interfere with the satisfactory

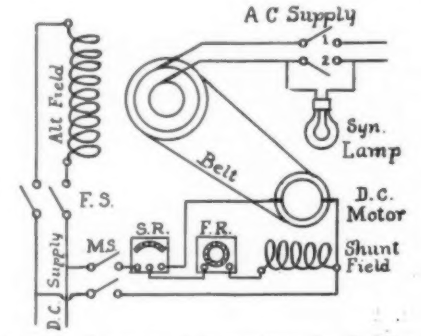


Fig. 62.—Diagram of Connections for Starting Alternating Current Synchronous Motor.

use of such motors on alternating current circuits, the most troublesome one being that of disastrous sparking at the commutator. In consequence of this serious defect, fan motors were about the only size put into commercial use until just recently, when renewed efforts to improve the working conditions to the extent of employing the motors for the heaviest railroad traffic seem to be meeting with some degree of success. What these modifications are will be treated in the second part of this topic.

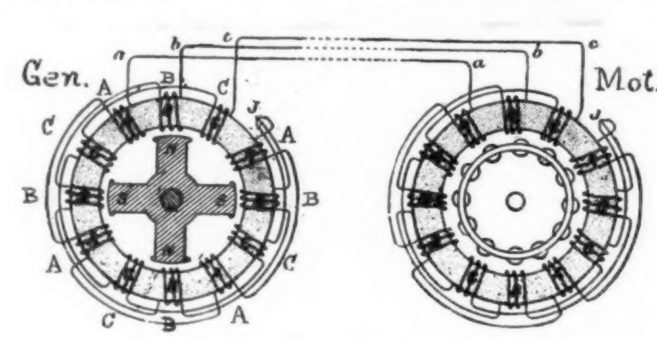


Fig. 65.—Three-Phase Multipolar Transmission.

As for the first practical motors—a sort still highly meritorious for large sizes and good regulating qualities—reliance is made upon the principle that any alternating current generator can, under favorable conditions, be made to operate as a motor. This means that, identically with direct current machines, the construction that is properly qualified to serve as a generator is inherently fitted to serve also as a motor. Favorable conditions, however, must be supplied, and these can be comprised under four heads: (*a*) During the starting process, the motor must be practically free from load; (*b*) auxiliary means must

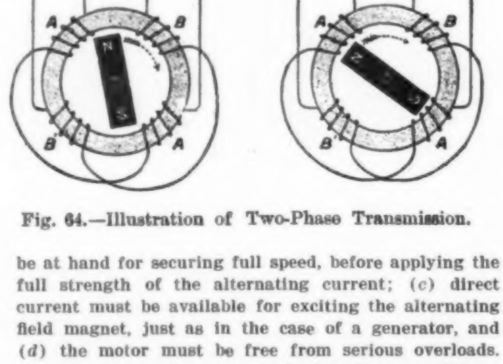


Fig. 64.—Illustration of Two-Phase Transmission.

be at hand for securing full speed, before applying the full strength of the alternating current; (*c*) direct current must be available for exciting the alternating field magnet, just as in the case of a generator, and (*d*) the motor must be free from serious overloads. It will at once be recognized that these conditions could not ordinarily be met outside a central station. In such a place a large motor might receive its current from some distant source, and displace a steam engine. The other machinery, along with suitable switchboard devices, and competent attendance would also be inferred.

A diagram of the essential connections for such an installation, but readily workable in a laboratory, or other experimental shop, is given in Fig. 62. The alternating current motor to be started and operated can be imagined to be the identical generator shown in Fig. 57, of the preceding chapter, with its separate exciter now used as the starting motor. In the diagram the single phase current from the supply is led to the two single-pole switches, marked 1 and 2; across one of these the synchronizing lamp is connected. With a low potential supply, a single lamp as shown, or several such in series, would be proper, but with ordinary high voltages, the lamp would be in the secondary circuit of a small transformer, the primary of which would be attached across the switch. The two concentric rings, in which the alternating current circuit terminates, typically represent the regular collector rings. Of course the reader will understand that the same diagram can as well represent the case of a revolving field machine. In the case here shown, the stationary field is connected through the field switch, *F S*, to the source of direct current—either storage batteries or some dynamo that happens to be running. From the same source, current would be taken to drive the starting motor, passing through a main switch, *M S*, and starting rheostat, *S R*. By means of a rheostat, *F R*, in the shunt field of this motor, any desired speed may be obtained for the synchronizing process.

It must be recognized that at every instant the alternating current motor, like one of the other sort, must generate an electromotive force counter to the supply. There must be some critical speed of the motor when its rate of alternations just equals that of the supply, and the instantaneous position of armature coils with reference to the field-poles such as to result in the production of an electromotive force just opposite to that of the supply. By adjusting the strength of the field the opposing E.M.F. can be made about equal to the other. When this condition of "synchronism" and "opposition" of phase is met, the fact is shown by the lamp being completely extinguished; at conjunction of phases, the lamp burns steadily and brilliantly, but at all other or intermediate conditions, the lamp dims or brightens, with a frequency of the difference in the rate of alternations from the two sources. When these "beats" take place sufficiently slowly, and the lamp is out, it is the critical moment to make the final movement of the switches. The complete steps will be as follows: With all switches initially open, and *F R* all out, close *M S* and start the D. C. motor; close *F S*, and then *A C* 1. Alternating current will then flow from the supply through the armature and lamp, and the combination of the two electromotive forces will produce rapid fluctuations of light. By means of *F R*, adjust the speed of armature to reduce this frequency, until complete extinction has been attained. Possibly adjustment of alternator field, by means of an appropriate rheostat, may be necessary. At the right instant *A C* 2 is to be closed, and simultaneously, it is well to open *M S*, else the alternator may be pulled ahead of the synchronous speed. Current will flow into the alternator armature, now a motor, no longer limited in amount by the high resistance of the lamp, but entirely dependent upon the phase relations of applied and counter electromotive forces. The greater the load the greater the current, the speed, however,

always being constant if the rate of alternations of the supply is kept fixed.

If no direct current is available for the start, an alternating current motor, of some self-starting variety, preferably an "induction" motor, can be substituted; this would then be obliged to drive a direct current exciter in addition to starting the main machine, but after the start this latter could drive its own exciter.

Single-phase synchronous motors have no choice of direction of rotation, running equally well in whichever way they are started; those of the two- and three-phase sort, in consequence of the phases following each in some definite order, do have a particular direction of rotation, but either can be secured at will by exchanging the two wires belonging to the same phase of the former, or by exchanging any two wires of the latter. Motors for more than one phase have valuable qualifications over those for single phases in that considerably greater output, for the same weight of materials, can be secured, greater overloads can be sustained, and under conditions of no load, they can be self-starting. Switchboard devices for starting these would follow the essential features of Fig. 62, the lamp or other detector being placed in any one of the phases. In practice, an ammeter would be inserted in one of the phases and a rheostat in the field; by occasional adjustment such a strength of field is provided as will allow the minimum current in the armature. This expedient, of course, reduces the line losses, and allows the system to work at its maximum efficiency, a property not possessed by other alternating current motors. An unexpected peculiarity is also present in the operation of synchronous motors, that they will continue to run when the field is given such a high value, as actually to make the counter E.M.F. greater than the applied. This is impossible with direct current motors, but can be explained for this sort by realizing the difference of phase relations. Below a certain critical strength of field, the armature lags behind its E.M.F.; above that, it leads; at the critical strength there is neither lag nor lead, and the circuit behaves just like one of the direct current sort, or it may be said to have a power-factor of unity. In a general distribution system, to which all classes of service may be connected, involving various inductive loads, it is common to find a large synchronous motor apparently running idly, but really operating with an over-excited field, and employed exclusively to improve the power-factor, and consequently, the regulation of the system.

Though limited to units of large size, say several hundred horse-power, and as yet to central stations, very great confidence is placed in the operation of such motors, and it is quite likely that large individual customers will yet be led to adopt them in place of the self-starting, but less efficient types.

The identical character of the construction of the generator and synchronous motor is clearly brought out in Figs. 63 and 64, the former for single, and the latter for two-phase apparatus. Here, for clearness, ring-wound stationary armatures and permanent-magnet fields are shown. Incidentally, the phase difference of the electromotive forces is represented by the differing angular position of the field magnets. That the motor exerts a counter electromotive force is shown by the arrows, but in applying the right-hand rule to prove the correctness of these directions, the reader must not forget that the motion must be ascribed to the armature conductors and not to the magnet. Similarity to direct current principles is brought out in a remarkable way by referring to Fig. 31, of Chapter VIII.

As the magnet poles of the generators of Figs. 63 and 64, bristling with lines of force, generate alternating currents in the armature conductors, these currents flow around the coils of the other machine, and they cannot but reproduce in that iron magnetic conditions identical with the original. This is only an illustration of the fundamental phenomenon, that a magnet can induce a current of electricity in a conductor, and conversely, a current can produce an equivalent amount of magnetism. It will be accepted that as the pole revolves it will carry the magnetism sweeping through the ring; also that in keeping with these changes, magnetism will rise and fall in the armature of the motor. If the field magnet be revolving at a critical speed, it will be urged or dragged in a continuous manner just as the driven magnet.

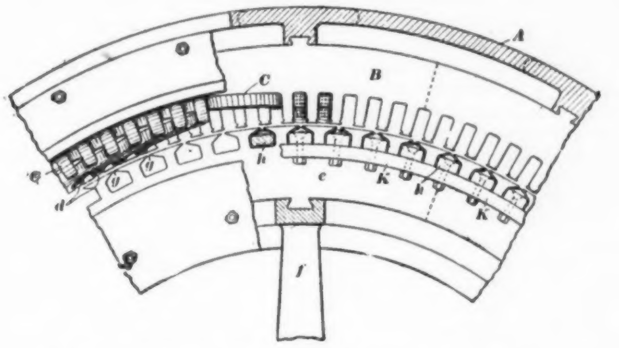


Fig. 67.—Partial Section Through Large Induction Motor.

The two-phase arrangement of Fig. 64 brings out a further principle, that the consecutive rise and fall in value of the magnetism due to the separate phases, *A* and *B*, results in a seeming rotation of the magnetism. Thus, as the *N* pole of generator moves from *A* to *B*, magnetism will shift from *A* to *B* in the motor, and so on around the ring, just in step with the changes in the generator. A field magnet in the motor will be dragged around, and even if synchronous speed is not first supplied, sufficient eddy currents may be induced in the solid iron of field to give a feeble torque, and allow the machine to be actually self-starting.

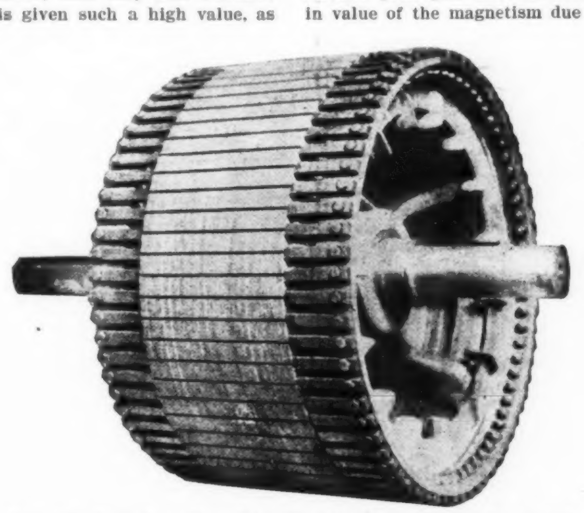


Fig. 66.—Secondary Complete, Showing Copper Bars Connected to End Rings.

A natural step in the development was then to provide for the most favorable production of these eddy currents and, even under conditions of load, to allow the motors to be fully self-starting. While to Ferraris, in Italy, and Tesla, in this country, belongs the discovery of the principle of this shifting or rotating magnetic field, the practical construction of motors embodying it is largely due to C. E. L. Brown, in Switzerland. He used a revolving member, or "rotor," consisting of a laminated core pierced near the periphery with numerous holes, parallel to the shaft, through which were thrust meagerly-insulated copper rods, with their outer ends soldered to copper end-rings, thus effectually short-circuiting them on themselves. No connection with an external circuit was provided, so whatever current flowed in these rods was due to electromotive forces generated by the action of the shifting magnetism. Considered apart from its iron core the electric circuits are seen to resemble the whirling part of a squirrel cage, whence the origin of the common graphic designation, "squirrel-cage" winding. The equivalent can be made from any direct current armature by wrapping bare copper wire around the commutator. In consideration of the fact that whatever currents flow in these circuits are produced by induction from the other member, just as in the case of a transformer, or induction coil, the name "induction" motor has become quite general, with the stationary part called the primary and the other the secondary. The names "field" and "armature" are not altogether distinctive, for that would involve calling a certain part the armature, when comprised in one machine, but the field when in the other. The names "stator" and "rotor" are common in European countries.

If the short-circuited direct current armature be suspended in bearings, and the separately excited field magnet rotated around it, such currents would be induced as to tend to drag the conductors along. With load absent, the speed with which the armature would follow the position of the field would at best be a little less, for if the latter moved just as fast as the other, there would be no cutting of lines of force, hence no current, and nothing to produce any torque. With the armature so forcibly held as to prevent rotation, yet with the field at full speed, ruinously large currents would be generated, just as in the case of a short-circuited coil in an ordinary generator or motor. The torque would be a maximum. Exactly in the same manner, when a short-circuited rotor is placed in a structure in which, though the material iron may be quite stationary, the magnetic condition may circulate, the conductors will be forcibly dragged in the direction of the shifting magnetism.


Fig. 68.—40-Pole Synchronous Motor, Adapted for Starting by Aid of Geared Induction Motor.

A diagram showing a four-pole revolving field generator and a ring armature, with an exact reproduction of the latter for the stator of a three-phase induction motor and squirrel-cage rotor, is shown in Fig. 65. To fit the number of poles, each of the phases, *A*, *B*, and *C*, is subdivided into four symmetrically spaced coils, and the coils are Y connected, as seen at *J*. In practice, drum or pole windings, with form-

wound coils, are preferred to the ring, due to less cost for labor and to lower self-induction. The armature winding shown in Fig. 61 of Chapter XIV is a practical one for the stator of a three-phase motor, and is the kind employed with the early forms, and still standard for the highest voltages. The distributed type of winding, closely imitating those for direct currents, and allowing for a better wave form, is preferred for low voltages. The American construction of short-circuited rotors consists of rectangular bars led through nearly closed slots in the core and bolted to copper end rings. Such is the kind shown in Fig. 66. A section from an actual working drawing is given in Fig. 67. This shows the method of dovetailing the segmental sheets as required for large motors, those of the rotor being attached to a spider, and those for the stator within a cast iron shell, or housing. The shapes of the empty slots, the conductors and their outer ends are brought out as clear as drawings will show. A comparison with the actual construction will alone give the complete conception.

To start induction motors something of the caution needed with those for direct currents is proper. Very small ones can be started by simply closing the switch. Dangerously large currents are prevented by the employment of relatively high resistance windings. Such uneconomical operation would not be tolerable with large sizes, and therefore to keep the currents within bounds, the start is ordinarily made by impressing a suitably low voltage on the stator windings. Such can easily be provided by bringing out taps from choking coils.

Though remarkably simple, and so rugged as to be almost free from injury, the squirrel-cage rotor is defective in the respect that it possesses a comparatively feeble starting torque. For many purposes a heavy load is applied at the start, and to cope with such demands a different rotor has been devised. This consists in putting on a winding which, though made of relatively large bars, still is grouped in as definite a manner as that on the stator. Ohmic resistances, often composed of cast iron grids, are included, at the start, in this secondary circuit, much as the starting resistance for a direct current motor. In keeping with the principles of operation of a transformer, putting resistance in a secondary circuit reduces the primary current, improves the power factor, and allows the motor to exert a torque exceeding that of the regular running conditions. The resistance can be exterior for the case of a continually variable speed, the connection being maintained through slip rings and brushes, or for purely starting conditions it may be placed within the rotor, and cut in or out by means of a loose knob and sliding rod at the end of shaft. When the resistance is cut out, the rotor is identical with the permanently short-circuited type. The latter is cheaper to build, less liable to injury from overloads and clogging from dirt, and is to be preferred for all uses wherever possible. Manual assistance by vigorous pulling on the belt is often relied upon to supply the motor's natural deficiency in this respect. The motor that is most efficient under running conditions may readily exert the feeblest starting torque.

A combination of some of the features of the two fundamental types of motors discussed in this chapter is given in Fig. 68. This represents a large synchronous motor arranged to be started by being geared to one of the induction type. The knob for operating the resistance in the rotor circuit of the latter is seen at the extreme left-hand end; the four terminals protruding from the lower part of frame suggest the two-phase winding. Collector rings on the shaft of main motor are for the direct current for exciting the revolving field, but the terminals for the stationary armature—or as well called the stator—are within the frame, purposely concealed from touch. After starting, the induction motor is removed from further use by slipping the small gear along the shaft, until out of mesh with the large one.

The next chapter will be devoted to the explanation of such motors as will operate on single phase circuits.

PAPER AND PULP MILL WASTES.

THEIR PRACTICAL UTILIZATION.

BY DR. THEODOR KOLLER.

In the paper industry, those residues that require special attention include the waste waters that are derived from the boiling, washing, and bleaching processes and the paper-machine, as well as from incidental processes. Fibers of all kinds, fine suspended mineral and vegetable substances, colors in solution, and chemicals of the most widely different character, constitute the impurities and the substances that are carried away. Among these the most valuable are the fibers, originating in the paper-making raw material used. To recover them, pulp retainers of the most varied construction, settling basins, and likewise filtering arrangements are employed. The most practical and the cheapest method, is to allow the waste water first to pass through a good pulp retainer and admit it to sufficiently large settling basins, of which several must be provided, so that they can be alternately used and emptied. In detail, their construction must be such that the water backs up over a large space and that the outflow takes place slowly and over a wide surface, so that everything possible will settle in the almost stationary body of water. The emptying of the separate divisions should not be prolonged over too great a period, because in the sediment, on account of the working of all the substances present, decomposition soon sets in, which also attacks the fibers, makes them less durable, or completely destroys them. The pulp substance recovered is admirably adapted for the production of gray or dark wrapping paper; consisting as it does, almost exclusively of the finest fibers, it does not require the least additional treatment but can be transferred directly to the beating engine, and is consequently in demand by pasteboard factories and well paid for by them, provided the mills themselves do not make that class of paper and have otherwise no use for it. To fit it for transportation, it must be pressed out to some extent in some manner. The waste waters of cellulose factories, especially carry away large quantities of valuable matter, and for these, such an arrangement is particularly advisable. As far as the separate branches of manufacture are concerned from which the waste waters proceed, the first is the waste lye from the rag-boilers; it contains very little fibrous matter, so that it may be left out of the fiber-collecting process. On the other hand, it is very rich in nitrogen, which originates in the grease, sweat, and other substances extracted from the rags, and as it also contains lime, it makes an excellent fertilizer. For this purpose, it is discharged into a vault or pit, whence it can be emptied as desired, the objectionable odor being removed by the use of some gypsum, which is also obtained from wastes; or we can use it for wetting down manure heaps, made up of other residual product. The waste fluids of cellulose boiling are different, according to whether soda or sulphite pulp is made; in the first instance the customary recovery of soda may be practised, whereby the thinnest lye, which can no longer be profitably calcined, can be employed for the solution of other soda solutions. For sulphite waste liquors no really useful and practical process of recovering, or the further utilization for tannin, sugar, or other substances, is known. They can, as a rule, however, be used very well as fertilizer after they have been mixed with an alkaline or calcareous waste, which is universally found in conjunction with them, in order to neutralize the free acids; this is an inexpensive process, when it is conducted as in the case of the rag-boiling lye, and where tests have been made in such a manner, they have resulted in the boiling lye being taken away and the waste water trouble obviated. In addition, this waste lye, on account of the bisulphite and tannic acid it contains, is an excellent substitute for alum, or sulphate of aluminia in rosin sizing; for brown and black dyeing it can also be employed to advantage.

The washing waters from the engine are more than any others those that should be utilized in recovering fiber. Those from the paper machine, however, that contain in addition clay, size, coloring substance, etc., in order to render these substances again useful, are best to be returned into use several times in such manner that they are run back for filling the engine, for dissolving starch and clay, or for rag boiling. Inasmuch as a certain quantity of water can only take up a definite quantity of foreign substance under prevailing conditions, it may readily be perceived that in this manner the losses may be greatly reduced. It may readily be understood that here the constitution of the paper is a factor of importance. In unsized, uncolored and non-loaded papers, such a process of utilization is uncalled for; those that are deeply colored, which would seriously contaminate the river, should, on the other hand, be used in grinding and washing the rags coming from the boiler, whereby the coloring matter will be in part fixed and in part destroyed. The chloride of lime residue stands also in connection with the waste waters; its employment as a fertilizer, as described, is not permissible. It is best to collect it in a vault and to transform it, by incorporation of soda solution, into carbonate of lime, or, by the addition of dilute sulphuric acid, into gypsum. Both are adapted in part for use as fertilizer, mainly when mixed with the above mentioned and otherwise rejected waste waters; on the other hand, when the residues were clean, it can be used as filling.

The carbonate of lime, not so well adapted for use as filling, may be regenerated in small lime-kilns and transformed into quicklime. Of less importance are the rosin, color, and kaolin wastes; if, however, they have accumulated or where they occur in large quantities, they are put together, allowed to dry spontaneously and may then be ground in a "kollergang" (edge mill), a suitable filling substance being added and used with ordinary papers as a substitute for earth color. An excellent earth color, however, a substitute for dark ocher and umber, can be obtained in sulphite cellulose factories, by a proper utilization of the pyrites residue, the so-called burnings; they consist, in great part, of oxide of iron. They must be crushed to pieces as large as a hazel nut, the smaller pieces screened out and washed in water. An uncommonly fine, soft, and very rich color is thus obtained.

The arrangement of such a washing plant, according to the quality of the material, may be very primitive; the operating expenses consist only of the labor, and the whole pays handsomely. The larger portions of the burnings that remain, consist chiefly of unburned iron pyrites which can then be again utilized in the furnace. We must look upon the gray arsenic sublimates, that form in the gas ducts and are usually washed out with the rinsing water, as a useless by-product in sulphite cellulose factories. This is a great detriment to fish culture, for these substances, that are absolutely and even in the most dilute form, injurious, are more harmful than all the waste water. They accumulate in the pipes in solid form, so that they can readily be collected, and in large quantities find ready buyers. As a result of the frequent plumbing work that has to be done, there gradually occurs in the gas generating apparatus, a cadmium residue, a metal that is scarce and costly, and is preserved in all other industries. Finally, from the sulphite lye, while at rest and in boiling, calcium monosulphite and gypsum are separated. The first can serve as a solid "antichlor," whereby it is transformed into veritable gypsum, or also as an addition to the various fertilizing substances mentioned; it may also be transformed, by dilute sulphuric acid, or by a warm solution of sulphate of soda, into gypsum, or by a similar solution of soda into carbonate of lime, in which latter case, it is recovered for the preparation of new boiling lyes, for which it is used, but for this purpose it is not found so well adapted, being as a rule, not finely divided but baked together and crusted.

Especially troublesome, primarily on account of their large volume, are the residues of soda recovery, i. e., caustification in soda cellulose factories. The residues consist principally of carbonate of lime, which is contaminated with soda, carbon, and other substances. Its utilization is best effected by burning, after drying it to a certain extent, and thus recovering from it the necessary caustic lime. Owing to its large quantity, it demands a continuous process and yields constantly fresh lime. For possible utilization for gypsum, it must be treated with dilute sulphuric acid, while as fertilizer it is only utilizable after all the soda salts have been completely neutralized.

Of the residual products that do not come in contact with water, we have to bestow our attention in wood pulp and cellulose factories, on the residues resulting from the cutting up and preparation of the wood, the sawdust, bark shavings, and other pieces of wood. The sawdust, burned in specially constructed furnaces, makes an excellent fuel, the shavings are used as litter for cattle and are sought by farmers for this purpose, and both together can be used in the production of a special wood pulp, but this can only be profitably done, with the help of boilers, specially made for this purpose. Any bark, larger pieces of wood, the chips from the separators, and the residue from the grinding apparatus, will not pay for special working up. As the last, although in operation the first, residual product, the rag dust must be mentioned. It forms, in itself, an excellent fertilizer, may,

however, also be worked for the finer fibers it contains in such manner that it is mixed with water and the water drawn off after a short rest, the fibers being drawn off with it and the dust, sand, and all heavier particles, left behind.

We must include in the residual products, the paper waste. Regarding its use it is not necessary to say anything, it is effected always and everywhere, and is referred to only as an example as to how the waste substances may always be used with the best results, and are really an important factor in the profitability of a paper and pulp mill and with the prevailing low prices are of constantly increasing importance.—Translated from Verwertung von Abfallstoffen for the SCIENTIFIC AMERICAN SUPPLEMENT.

FIXATION OF ATMOSPHERIC NITROGEN.*

SOME NEW FERTILIZERS.

BY PROF. TH. SCHLOESING, OF THE PARIS UNIVERSITY.

Upon the appearance of nitrogen in the field of chemistry and biology some thirty-five years ago, it was given a name (azote) which signifies inability to maintain life, but since then, the more it has been studied, the better is it established that it is indispensable to life. It is true that nitrogen cannot keep up animal respiration, and on account of this fact, by comparing it with the other essential element of the air, oxygen, it was somewhat neglected and relegated to an inferior place.

When chemical analysis multiplied its application, it was seen that nitrogen was present in all living matter, and it was natural to conclude that it played an important part. We find that animals require nitrogenous matter. For instance, a dog when fed on nothing but sugar soon languishes and dies. In the same way a plant when placed under the conditions where it does not assimilate nitrogen under one form or another, can scarcely be said to develop. It utilizes the reserve supplies of the seed from which it sprang until it exhausts them, after which it remains in a sickly state. Thus we find that nitrogen is necessary for life, and this idea serves to stimulate our interest in this element, and we desire to be better acquainted with its relations to living organisms. Nitrogen is present either in the free state or combined. In the former it constitutes the main portion of the atmosphere, but it cannot be utilized for life in this state, as concerns animals. Animals do not obtain their nitrogen from the air, but from the vegetables which they feed upon, and this leads us to an interesting question as to whether the atmospheric nitrogen can serve for vegetable nutrition. We must distinguish here, however. There are some plants which have the faculty of fixing the free nitrogen of the air. Certain inferior plants such as sea-weed have the same property, but these will not be considered here. As to cultivated plants, some of the vegetables seem to be the only ones which will fix the free nitrogen, but while these constitute a food of the first rank, they are not sufficient. We wish as a food, wheat, potatoes, etc., and also to utilize the beet for producing sugar and alcohol, linen for garments, and others, such as the grape and the tobacco plant. Animals, on the other hand, need barley and corn. In such cases we require nitrogenous fertilizers. No doubt, when deprived of such, they can arrive at a certain production, owing to the use of certain secondary sources of nitrogen by the plant, of which they are always assured. But this production is limited and will scarcely content any other than dispersed and poorer populations. Thus nitrogenous fertilizer is not only useful, but necessary, and to secure all its advantages, it does not suffice to take it in the form of manure from the domain which is cultivated, but it must oftenest be imported under other forms from outside.

Thus we see that nitrogen is indispensable to animals, that it is given them by vegetable matter and that a great part of the latter, in order to reach a sufficient production, must receive nitrogenous fertilizers obtained outside of the farm. Nature offers us great provisions in the guano of Peru and the Chili nitrate of soda, and these have been a great benefit to agriculture in all countries where they are used. But the supply of guano is exhausted, and it seems likely that in thirty or fifty years the nitrate beds will also be used up. Coal is another source of nitrogen. When vegetable matter dies, it is usually the seat of reactions which transform it profoundly. Microbes attack it and leave but little. They work very actively and play the part recognized by Pasteur in the world of economy. Without them the disintegration of organic matter by the purely chemical action of oxygen would go on with exceeding slowness. One proof will be sufficient, this being a sample of wheat from Egypt, preserved for ages, coming from the burial place of sacred crocodiles at El Lahoun. They were buried at three feet in the sand without other preservation than the climate of the country, and the humidity of the soil never reached the point where microbian life commenced. Under the action of oxygen, the wheat has only darkened in color, and keeps its form and consistence. In conditions where coal is formed, the vegetable matter has not perhaps resisted as well, but here we have not the absence but an excess of water, and this gave a certain protection. Instead of consuming entirely and disappearing, as in the soil, it has left an important residue which always contains a good proportion of nitrogen, from one to two per cent. It is this nitrogen which in the treatment of coal by heat, gives ammonia, and such is the origin of this production of sulphate of ammonia, which now reaches 760,000 tons. The 800 million tons of coal consumed every year in the world would give much more sulphate if the recovery of ammonia was applied. This cannot be done entirely, of course, but there is no doubt that in this direction there may be a great increase in the production of sulphate of ammonia. This is a source of nitrogen which is very important for agriculture. But even this source has its weak point like the others, in its lack of duration. In a few centuries the sulphate of ammonia from coal will be also lacking, from the exhaustion of the coal beds. But there will be a continued need of fertilizer, on the other hand. This leads us to consider the nitrogen of the air as a source of supply and gives an added interest to the recent attempts to utilize the nitrogen for the purpose of fertilizing.

Two solutions have been given to this important problem. Messrs. Frank and Caro obtained a nitrous compound, calcium cyanamide, which can be used in agriculture, by direct fixation of atmospheric nitrogen upon calcium carbide. Again, Messrs. Birkeland and Eyde combine the nitrogen with the oxygen of the air to obtain nitric acid and the nitrates. The production of the calcium cyanamide is as follows: We heat pulverized carbide of calcium to 1,000 deg. C. in crucibles in which nitrogen is introduced, and the latter is absorbed, giving the cyanamide. $CaC_2 + 2N = CN_2Ca + C$. The carbide used here is the ordinary kind. By observing the pressure in the nitrogen supply pipes we see that it rises when the operation is finished. Using charges of 300 pounds this requires five or six hours. The product is hard and of a blackish gray color, containing about 20 per cent of nitrogen, but theoretically it can reach 30 per cent should pure carbide be used. Under the action of water, this compound gives ammonia and calcium carbonate. $CN_2Ca + 3H_2O = 2NH_3 + CO_3Ca$. In the soil, the cyanamide is more slowly transformed and finally all the nitrogen passes into the state of ammonia. By being nitrified, it is adapted for assimilation by the roots of plants and thus is a very useful fertilizer. Trials have been made of this compound on a rather large scale, and although the results are not as yet uniform, it appears that it is equal to an ammoniacal fertilizer having the same percentage of nitrogen. At present, steps are being taken to produce it on a large scale. In Italy a plant installed at Piano d'Orte uses 3,000 tons of carbide and this will be soon doubled. The Société Française des Produits Azotées is erecting a plant in the Savoie region and will use about the same amount of carbide. To obtain the current for the electric process used in preparing the carbide, it uses the stream of Eau Rousse, with a turbine-dynamo station erected for this purpose.

Considering the second process for nitrous products as used by Birkeland and Eyde, it is based on the combination of the nitrogen and oxygen of the air, and a similar method has already been described. Therefore we will not treat of this process at length, except to recall the fact that the air is made to pass by a powerful electric arc contained in a furnace, and the gaseous mixture which comes out contains air in excess and a quantity of nitrous oxide. The temperature of the mixture leaving the furnace is about 1,470 deg. F., and that of the arc is near 5,400 deg. F. At the new Svaelgfos-Notodden works there will be thirty furnaces in operation, representing a total of 34,000 horse-power. The nitric acid passes into apparatus containing limestone, and forms a nitrate of lime solution, which is then concentrated. The rest of the nitrous gases form nitrites in other apparatus.

The Norwegian Nitrate and Hydraulic Company now control the plants of Notodden and Svaelgfos-Notodden. This relates to the use of the Rjukan fall, which is one of the largest in the country. It will furnish 220,000 horse-power, which can be used for the above process. The company propose to take 100,000 horse-power from the fall by building a first plant half-way up, and the remainder can be used at a later period. A lake of 53 square kilometers will be used as a reservoir in this case and the water arrives by a tunnel $2\frac{1}{2}$ miles long into the feeding reservoir, from which the penstocks lead to the dynamo house. Here will be located ten Pelton turbines of 12,000 horse-power each. Cables will take the current to the chemical works, which is situated farther on. The products of this great works will be shipped on a special railroad track thirty miles long and are then transferred to ocean steamers at the port of Skien. This vast enterprise has already been put under way. Joined to the 34,000 horse-power of Svaelgfos-Notodden, the 100,000 horse-power of the new plant will give in all 134,000 horse-power, corresponding to 53,000 long tons of nitric acid or 90,000 tons of nitrate of lime.

About one-fifth of the enormous quantities of nitrates exported from Chili are used in various industries, especially for explosives, but the greater part is devoted to agriculture. It may be asked whether the newly-produced nitrate of lime is as good as the nitrate of soda which is now in use. Agronomic scientists know that the nitrogen which feeds the roots of plants in the soil takes essentially the form of nitrate of lime, and this leads us to expect a great efficacy from the nitrate of lime when used as a fertilizer. But experiment confirms this. The most recent, carried out in 1906 in different regions in France, is of value as it includes important tests, and its results should inspire confidence. It has been definitely established by widely varying kinds of cultivation on a large scale, that there is a complete equivalence between the same amounts of nitrate of soda and nitrate of lime.

We thus have the two processes which have already appeared for giving a practical solution to the problem of the fixation of the free nitrogen of the air, and this problem is a capital one for the future of agriculture and of humanity. Seeing that the question of nitrogen is so active at present among experimenters, there may arise other processes of the kind, but at present we must consider only those which actually exist, and for the time being we have in Europe only the calcium cyanamide and the nitrate from Notodden. But there will hardly be any struggle between them. In fact, the 760,000 tons of sulphate of ammonia and the 1,600,000 tons of nitrate of soda which are consumed annually represent 415,000 tons of nitrogen, while on the other hand the 15,000 tons of cyanamide and the 90,000 tons of nitrate of lime which will only come upon the market a few years hence, represent but 13,800 tons of nitrogen, or but 3 per cent of the former amount. There will thus be ample room for the new products without making them conflict or enter greatly into competition with the former ones. Later on, when the Chili nitrates have disappeared, the state of affairs will have changed, and we will see a greater competition between the new processes.

On the side of the producers the situation is thus favorable. What, then, do the agricultural interests think of the question? On the appearance of the new nitrate of lime the first idea was that the nitrates would become cheaper in consequence. This has not proved to be the fact, and there is scarcely any reason that the prices will be lowered, seeing that there is always a large consumption of fertilizers, and even admitting the objections made by farmers to the high price of nitrates, they none the less continue to use them, and find it to their advantage.

Although the present paper treats specially of the nitrogen of the air, we may remark a kindred subject, that is, the experimental work of Messrs. Müntz and Lainé upon the production of ammonia and nitrate of lime by their newly discovered method. They extract ammonia from a most common material, peat, which they treat to this end by means of superheated steam. A liquid is thus secured which contains the ammonia in the state of sulphate. They treat this liquid matter in a percolating column in which air is mixed with limestone, and in this way the inventors succeed in obtaining a product which consists of nitrate of lime.

* Extract of paper read before Association Française pour l'Avancement des Sciences.

CURIOUS RAILWAY COLLISION IN INDIA.

THE BEWILDERING RESULT OF A HEAD-ON SMASH-UP.

AMONG the many curious and bewildering positions in which the debris of a serious railroad wreck is frequently found, we doubt if ever it presented a more striking spectacle than is portrayed in the accompanying illustration of a smash-up which occurred on an Indian railway. The illustration shows the effect, or rather part of it, of a head-on collision which occurred on December 27 last near Ludhiana, on the Northwestern Railway of India. Particulars as to the disaster are meager, but the calamity occurred on a single-track road, and was due to the head-on collision of two passenger trains, in which twenty people were killed, and a much larger number more or less seriously injured.

Although this is one of the most picturesque and startling of the many collision photographs which have come to this office, it is by no means unusual for the locomotive to assume the position shown in our photograph after a head-on collision. Nor is the reason far to seek. When two fast passenger trains heavily laden and running at high speed collide, the combined energy stored in the two trains may easily amount to from 50,000 to 75,000 foot-tons. Much of this energy is expended in telescoping the cars one into the other, back of the locomotive, and frequently the debris of the forward cars, crowded forward by the energy of the cars behind, is piled in a confused heap around the locomotives. The locomotives themselves frequently are found after a collision with their front ends tightly wedged together, but with their wheels still upon the rails and the two engines approximately in line with the track. But it sometimes happens that the jar of the first contact causes front ends to lift slightly, the action being assisted by the crowding of the forward trucks beneath the front platform, and immediately this occurs the massive engines under the thrust of their respective trains are wedged up bodily into the air in some such position as is shown in our engraving. It was probably the wedging action of the trucks which started the upward lift in the present case; for these trucks can be seen lying on the ground between the driving wheels of the two engines.

From the Illustrated London News.

THE ENERGY OF THE COLLIDING TRAINS EXPENDED ITSELF IN THE LINE OF LEAST RESISTANCE, WHICH IN THIS CASE IS VERTICAL.

CURIOUS RESULT OF HEAD-ON COLLISION IN INDIA.

THE MODERN ICE HOUSE.*

ICE-HOUSE construction is a topic of great interest to a large class of readers, as evidenced by the questions that are constantly arising as to the methods of preparing buildings either for the storage of ice or for cooling purposes. In many sections of the country it is common to find a small ice house as one of the buildings requisite to complete the farm equipment, and some comments therefore regarding an ice house suitable for the needs of the average farm may not be without interest at this time. It should be remembered, however, that in planning his ice house the farmer should not make the mistake of constructing a building too small, except he live in a section of the country where the winters are long and severe. It is not so much a question of how much ice he needs for family use as it is of how much he is likely to waste, and whether it will last through the hot season until cold weather again arrives. A large block of ice will last much longer relatively than one somewhat smaller.

A convenient size for an ice house for the farm is about 15 to 20 feet square in plan. Allowing 1½ feet for the space between the two walls and the space between the inner wall and the ice, this will give a block of ice 12 to 17 feet square, and if it is 12 to 15 feet high it will contain a sufficient number of tons to meet average requirements. The loss of ice from melting is very great in all ordinary ice houses, and especially is this true where it is taken out daily in such small pieces as is usually the case.

The house should be built above ground, and if possible it should be placed where it will be more or less protected from the noonday sun. A low-cost ice house can be built with ordinary lumber and by any one handy with tools. According to a writer in an exchange, the essentials to be observed are: First, drainage below and ventilation above; second, a perfectly tight foundation, as warm air rises and a current once started through the ice will cause it to melt very rapidly; third, a double wall surrounding the ice on the sides and top.

The foundation should be made of brick, concrete, or stone masonry, and in which sills 2 x 8 should be bedded in cement. On this erect 2 x 8 studding, 24 inches apart. On the inside for the inner wall ½-inch sheathing material may be used of almost any kind of lumber. Some durable wood is to be preferred, as these boards are a[illegible] to decay quickly. For the outside good novelty siding may be used. It should be free from knotholes and cracks. The rafters should be 2 x 4, with sheathing on the under side. It is important to have air spaces between shingles and sheathing beneath the rafters, as every one knows how hot it gets under a barn roof in summer. The space between the two walls on the four sides may be left empty if the outer inclosure is very tight, as a dead air space is one of the best non-conductors. But it will not be a dead air space if there are holes or cracks in the siding, but the air will circulate and prove of little value as a non-conductor.

If the ground on which the house is situated is of a gravelly, porous nature, no provision need be made for drainage, as the water will be absorbed as fast as the ice melts. Otherwise the floor should be graded off, so as to slope to one point, where surplus water may be taken off by means of a trapped outlet pipe to exclude all air while allowing the water to escape.

The door opening of the house should begin about 4 feet from the ground, and extend upward nearly to the top of the roof. The outer may be made in two or three sections, and the inner inclosure supplied by boards crosswise, put in as the house is filled and taken out as it is emptied. It is a mistake to provide too much ventilation. For an ordinary house 1 foot square openings at each end under the apex of the roof are sufficient, and it would be of advantage to provide for closing these on warm days.

In filling the house, never lay the ice on the ground. The warmth of the earth will melt the ice continuously. The cakes of ice should be laid on old rails or any kind of timber. Straw or cornstalks are not good, as they crush tightly to the earth and get wet, and water is a good conductor of heat.

The ice on the pond should be worked out carefully and the blocks made of uniform dimensions. In laying, the joints should be broken and a space of 8 to 12 inches should be left between the ice and the wall. This may be filled with straw, the same material being used to cover over the top of the ice after the house is filled. The house should be painted white.

An ice house 15 feet square and 12 feet high will require approximately the following amounts of lumber: 26 pieces 2 x 8 inches by 12 feet; 8 pieces 2 x 8 inches by 15 feet, 14 pieces 2 x 6 inches by 10 feet, 720 feet of sheathing, 850 feet siding, and 900 feet shingles. It will cost at the present prices of lumber about $80, independent of the foundations.

* Carpentry and Building.

Fluorography.—Process whereby lithographic or photographic pictures can be transferred to glass. Ink: 400 parts of glycerine, 400 parts of water, 100 parts of fluorspar, 100 parts of tallow or suet, 100 parts of soap, 50 parts of borax and 50 parts of lampblack. Transfer to glass, the same as with lithographic stone. The drawing is bordered with wax and sulphuric acid (64 deg. to 65 deg. B.) poured on it. After 20 minutes the acid is poured off, the plate washed with plenty of water and potash solution until all acid is removed, then again washed in water and dried with warm rags.

THE EDISON CONCRETE HOUSE.*

CONCLUSIONS OF ENGINEERS CONCERNING PRACTICABILITY OF THE PROJECT. THE PURPOSE OF THE INVENTOR.

BY E. S. LARNED, C. E.

MR. EDISON states that his idea of a cheap concrete house is primarily intended for families living in the congested tenement districts of the large cities, who find at present a minimum rental of $9 per month for two or three small rooms with poor light, poor air, poor sanitation, accompanied with appalling fire risks and generally unattractive and demoralizing surroundings.

In order that the cost of living should not be enhanced, it is necessary, in taking these families into the suburbs or country districts, to fix the rental sufficiently low so that the difference between the present rates and the proposed rate will cover the cost of trolley transportation to and from the city or place of employment.

Mr. Edison claims that the cost of the proposed house is estimated at $1,200, including plumbing, heating, and lighting fixtures. The house is intended for two families, and the rental required on a five per cent investment basis would be sufficient under the present conditions to cover more than the expense of transportation of the head of the household.

* Reprinted from the Cement Age.

FIG. 1.—MODEL OF THE PROPOSED TWO FAMILY $1,200 CONCRETE HOUSE.

The photograph published herewith, Fig. 1, shows the proposed house. It suggests a building more attractive in appearance than usually occupied by families for whom it is intended, and while Mr. Edison recognizes that molds for a less ornate building could be produced for much less money, he holds that the small additional expense, representing not over an annual interest charge of $40 in the cost of the forms, is more than justified by the improved appearance and the general satisfaction of the occupant and community at large.

It may be suggested, however, that the design seems poorly adapted to concrete construction, owing to the irregularity of outline and amount of detail attempted. This is a matter of judgment and taste, and, of course, could be modified at will.

The proposed size of the building is 21 feet by 49 feet, and 35 feet high, not including the cellar. The walls will be 12 inches thick reducing to 8 inches on the second story, and it is proposed to make the roof 6 inches thick. The floors and all partitions will be uniformly 4 inches thick.

Mr. Edison's idea is to construct these buildings upon sandy or gravelly areas, furnishing material for the concrete from the necessary excavations. The purpose of this, of course, is obvious in reduction of first cost, provided suitable materials can be found within the limits of the necessary excavation, but this limitation, if imposed, would seriously restrict the development of this class of buildings, for the reason that few areas adapted to cheap construction will be found furnishing satisfactory material for concrete, or material in sufficient quantity for construction within the limits of the cellar excavation.

The necessity of having good sand and good gravel at once suggests the difficulties experienced in most communities to obtain these materials of suitable quality, and it is fair to presume that in the majority of instances the sand and gravel or crushed stone would have to be brought to the work from sources as near by as possible.

The molds will consist of cast iron plates, but as yet the detail of dimensions has not been definitely fixed. The exterior plates for the wall forms will probably be from ¾ inch to ⅞ inch in thickness; the interior plates ½ inch in thickness; the underside of the floor molds and roof molds probably from ¾ inch to ⅞ inch thick, while the upper side will probably be ½ inch thick. The molds for interior partitions will probably be ½-inch plates. All mold plates are to have milled edges and faces with flanged joints drilled for dowel pin and bolt connections.

The inside faces of the mold plates will be nickel-plated or faced with brass where intricate tracery and detail is attempted in the finish.

It is expected that two houses per month can be constructed from one set of forms, and in order to secure a reasonable variety in design it is proposed to have six sets of molds, the approximate cost of the six sets being about $105,000, but [illegible] provided, the first cost would b[illegible]

The exterior and interior wall plates are connected and held in relative position by rods to pipe sleeves.

In the use of cast iron for mold plates the probability of occasional breakage in handling must not be overlooked, and the question of time and cost of renewals is of the utmost importance.*

It would naturally be found advantageous to have the plates of as large surface area as possible, but this is limited by the use of cast iron, of the thickness proposed, and, again, the larger the sizes the greater the danger of breakage.

Mr. Edison proposes to erect and take down the forms by means of four small electrically-driven derricks, and expects that it will take two days for erection and two days for removal.

Mr. Edison's preliminary estimate of the approximate weight of the molds for one house is 280,000 pounds; the writer's estimate amounts to something over 450,000 pounds. In either case, the question of transportation of these molds by railroad or team is not only an item of considerable expense, but sug-

* Mr. Edison states that this has been allowed for at four per cent depreciation.

FIG. 2.—EXPERIMENTS TO DETERMINE THE FLOW OF CONCRETE IN WOOD FORMS 4 INCHES SQUARE IN CROSS SECTION.

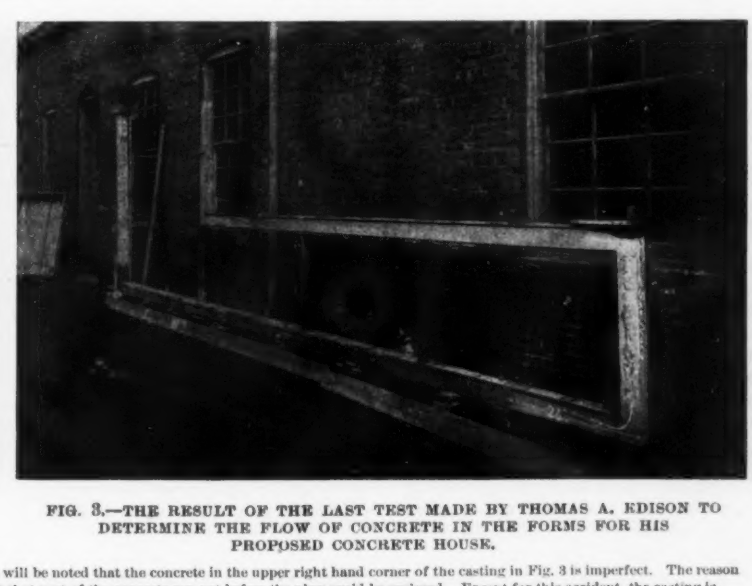


FIG. 3.—THE RESULT OF THE LAST TEST MADE BY THOMAS A. EDISON TO DETERMINE THE FLOW OF CONCRETE IN THE FORMS FOR HIS PROPOSED CONCRETE HOUSE.

A comparison of Figs. 2 and 3 will show that the test of Fig. 3 was much more severe than the previous one. It will be noted that the concrete in the upper right hand corner of the casting in Fig. 3 is imperfect. The reason for this was that shortly after the concrete had been poured, the plug at this point was pulled, with the result that part of the concrete ran out before the plug could be replaced. Except for this accident, the casting is practically perfect. A number of plugs were inserted at various points in the form as shown in Fig. 3. The arrows indicate the direction of the flow of the concrete from the hopper into which it was poured.

THE EDISON CONCRETE HOUSE.

gests also the possible necessity of protecting some of the more intricate and decorative molds by crating, in order to avoid breakage, which, of course, would add materially to the expense.*

The reinforcement proposed for the floors and roof, and elsewhere where needed, will consist of ½-inch and ⅝-inch rods. It is not yet definitely determined whether they will be round rods or some system of deformed bars. It is proposed to place all of the reinforcement in position in advance of the concrete operations, and the rods will be held in their relative positions by wiring or spacers.

Pipes for gas, water and all plumbing, also ducts for electrical wiring, are set in position in the form in advance of concreting, and the flues for chimneys are formed by thin metal forms which are left in position.†

It is proposed to have a 100-horse-power boiler and engine on trucks furnishing the power to drive motors connected with the four small derricks, concrete mixers, and elevator plant, which will also furnish any other power required.

It is also proposed to install three or four large mechanical mixers on the ground adjacent to the building, these mixers so arranged as to discharge into a storage hopper, from which the concrete is conveyed by bucket elevator to the distributing hopper at the top of the building, from which the material flows through pipes into the molds. A specific gravity device is to be attached to the storage hopper, and the consistency of the mix carefully watched and kept uniform.

It is also proposed to use plungers, power driven, operating from the top in the molds as the concrete rises, to keep the same agitated, and prevent the segregation of materials, serving also to expel the confined air, and secure a perfectly uniform face, and also assist in forcing the flow of the material into and throughout the horizontal passages.

Mr. Edison claims that in his experiments he finds that concrete of the proposed consistency and composition expands in setting a very small fraction of an inch in the greatest diameter of the proposed house, and he believes that subsequent contraction and expansion in the walls can safely be neglected in the reinforcement introduced.

Mr. Edison proposes to use a mixture of 1 cement, ? fine sand, and 5 [illegible]ne or gravel, passing the ½-inch mesh sieve [illegible] [illegible]ealizes that the serious problem involved is [illegible] prevent segregation of materials while being deposited and distributed, and claims to have solved this difficulty by the addition of colloids or some electrolyte in small quantity, which adds to the viscosity of the combined material, facilitates the uniform flow and prevents segregation. Mr. Edison also suggests that colors may be added to the mixture, if desired, but claims that he is experimenting with specially prepared paint for exterior application, and is seeking with some promise of success, a paint that will penetrate and mechanically combine with the concrete. This treatment, however, is expected to be a considerable item of expense, using a preparation of bismuth or cobalt, and experiments are now being made in the use of barium. The use of colors or the cost of painting with such preparation as Mr. Edison may develop has been omitted in his preliminary estimate of $1,200.‡

This preliminary step is attended with only one detail of special interest, and that is in the exact leveling of the top of the 12-inch monolithic cellar walls to receive the wall molds.

At the West Orange laboratories a few experiments have been made to determine the flow of concrete, and the illustration herein reproduced, Fig. 2, indicates the method pursued.

The first experiment represented by the two figures in the center of the picture consists of 4-inch board molds, set vertically with two horizontal connecting ribs of the same size. The concrete in each case was poured into the top of the vertical member and flowed by gravity alone into the horizontal molds and up the opposite vertical molds, apparently filling the same perfectly, and without any apearance on the exterior of the segregation of materials.

The last and most important test consisted of two upright members 10 feet in height, each 4 inches in cross section, connected at the base by a horizontal form of the same dimensions.

As one looks at the picture, the concrete was poured into the hopper of the left-hand vertical mold by means of buckets intermittently emptied. The forms were not jarred during the flow of the material, and as indicated in the right-hand vertical form, the concrete succeeded in rising 54 inches above the base.

At the time of the writer's visit to the laboratory, the forms were still on this last section of concrete poured, and it was impossible to judge of the uniformity of the concrete formed. An examination of the photograph suggests at least a very smooth face on the side of the concrete exposed, and reveals an additional fact of much interest, and that is the apparent settlement of the concrete in the right-hand vertical arm of about 4 inches in a height of 54 inches.

Possibly this was occasioned by leaky molds, which, however, did not appear to be the case, when they were first examined, but if such settlement occurs in building operations conducted in the manner proposed, it is likely to offer serious difficulties.*

It was explained that in this experiment it was impossible to obtain concrete of as uniform consistency and composition as will be obtained in the actual work of construction.

It may be granted without question that a system of iron molds accurately fitted and duly marked for quick assembling is entirely feasible. Mr. Edison's estimate of the weight, 280,000 pounds, is not borne out by a reasonably careful estimate, assuming from Mr. Edison's own statements that the exterior wall plates would be ¾-inch cast iron, the interior wall plates ½-inch, plates for the under side of floors and roof ¾-inch, with ½-inch plates for the upper side, and ½-inch plates for all partition walls.

We find approximately 20,000 square feet of wall and floor area above the foundations, weighing approximately 450,000 pounds, without taking into account the flanges, bolts, and pins.

If $25,000 be a fair estimate of the cost of molds weighing 280,000 pounds, it would appear by simple proportion that molds weighing 450,000 pounds would cost about $40,000. This is on the basis of 9 cents per pound, which must include planing the faces and edges of each mold plate, drilling of flanges for pin connections, and drilling of plates for bolt connections, and nickel-plating on the side next the concrete. It will be noted in the above estimate of weight that no allowance whatever has been made for the cellar wall molds. In the detailed estimate to follow, however, we will assume that $25,000 is the cost of forms.†

For purposes of illustration, let us assume that the molds and plant are delivered to the town f. o. b.‡ cars, and have only to be hauled to the site of the building. The cellar has been previously excavated, and is ready for concrete operations.

It is proposed to erect the molds by means of four small derricks, one at each corner of the building, and it is apparent that some assortment must be made as the molds are delivered from the cars, in order to put the plates under the derrick which will place the same in correct position.

Mr. Edison allows two days for the erection of the forms, including the placing of all reinforcement, the introduction of pipes or ducts for the same and flue forms, and it would certainly seem as if this time would be well occupied.

It is apparent, of course, that without a second set of molds for use in building immediately adjacent, the power and mixing plant must remain idle during the hardening of the cement, and the force of trained men which must be required for this operation also remains idle, or practically so.

It will probably take as long to remove the forms as to erect them, the chief difficulty being found in the plates on the inside of the building, which, of course, cannot be handled by the derricks and must be taken down by hand.

Without an actual demonstration, it is useless to state that the work cannot be done in the time named; for this reason an expression of opinion is reserved.

If, as estimated, two buildings per month can be constructed from one set of molds, it is apparent that for the greatest economy the molds should be used to their fullest capacity. This at once suggests the time necessarily lost by stormy weather, and in our northern latitudes, the disadvantage and expense of attempting work of this nature during the months of December, January, and February.

I give below a detailed estimate of the probable minimum cost of the proposed cement house. It will be observed that in the allowance for interest and depreciation, I have assumed that 24 houses could be built from one set of molds per annum, and have made no allowance for general expenses or contingencies. The fixed expense for labor and organization has also been neglected during the time between the pouring of the concrete and the removal of the molds.

Estimated Minimum Cost of House.

Cellar excavation, 250 cubic yards at 30c......	$75.00
Concrete, 200 cubic yards, 1-3-5 mixture—	
Cement—206 barrels at $1.50 (net).......	309.00
Sand—94 cubic yards at $0.65...........	61.00
Stone—156 cubic yards at $1.50..........	234.00
Cost of mixing and placing same at 50c......	100.00
Steel reinforcement, 10,000 pounds at 3c......	300.00
Forms, erection and taking down, approximately 20,000 square feet, 225 tons at $2..	450.00
Transportation (short haul by team) of molds and plant including installation of latter.	125.00
Plumbing and heating (reported bid)........	175.00
Windows, doors, and wood trim including paint	250.00
Fixtures	50.00
Total cost, labor and material...........	$2,129.00
Molds and plant estimated cost $40,000 (Edison).	
Allow 20 per cent interest and depreciation divided among 24 houses..................	333.00
Total cost	$2,462.00

N. B.—No allowance made for general expense or contingencies.

It is at once apparent that the construction of a single house by the method proposed would be prohibitive in cost, unless the houses upon completion so commend themselves by reason of their fireproof qualities, low cost of maintenance, and practical indestructibility, that they would be in demand rather than cheaper forms of construction.

In this connection, it is of interest to note the extent of the equipment for railroad transportation. The molds weighing 450,000 pounds would require 10 cars of 22½ tons capacity each, the derricks, boiler and engine, and mixing plant would require at least 4 cars more, making a train of 14 cars, which if transported at a fair average rate of $2 per ton would amount to $600.*

The whole idea of Mr. Edison's proposition is based upon the flow of liquids. Concrete, of whatever composition, can at least only be called a semi-liquid, and if the medium be sufficiently fluid to insure its flow under gravity alone, it would be, under natural conditions, impossible to maintain the aggregates in equilibrium or suspension.

This condition is also materially affected by the size of the aggregates used, and the rate of flow is likewise affected by the same elements.

There would seem to be no particular difficulty in filling the vertical molds with reasonable certainty by pouring the concrete from the top of the building, but the flow of this material through the horizontal floor forms, impeded by the necessary reinforcement, held in position by wiring or spacers, with occasional splices, and perhaps crossings, is the doubtful problem, and unless segregation of materials be prevented, and the horizontal molds completely filled before the initial set of the cement, it would be natural to expect irregular and incomplete results.

Mr. Edison proposes to facilitate the flow of the material and assist in the prevention of segregation by the introduction of a colloid, which may be clay in a very fine state of division, an electrolyte, or possibly hydrated silica, any one of which will serve to reduce the mixture to a more or less gelatinous condition, and by the viscosity attained hold the aggregates in equilibrium or suspension.

In the opinion of the writer, the introduction of a colloid may assist somewhat while the material is in motion, but when it comes to a rest, as when the molds are completely filled, it will not prevent segregation.†

The addition of a colloid would also, in the opinion of the writer, retard the hardening of the cement to an extent to seriously delay removal of the forms.‡

It is entirely unlikely that in such a mixture a concrete of 1-3-5 proportions in flat slab construction would be even self-supporting at the end of six days. This is further emphasized by reason of the necessity of using very fine sand, which of itself retards the hardening of cement, particularly in so lean a proportion as 1 to 3.

* Mr. Edison calls attention to the fact that houses are to be erected in rows and in large numbers at particular localities. Isolated work is no part of the scheme, hence transportation is a small item per house.

† Mr. Edison states that he has decided to put the pipes outside of the walls in most cases like hotel and sanitary plumbing.

‡ While Mr. Edison has no satisfactory colors at present he is convinced that this expense will be trifling. He adds that he has estimated for staining walls and for red tiling color for roof. Subsequent experiments were to get a variety of color.

* Since the above was written another experiment has been made and it is stated that every part is perfect.

† Mr. Edison states that his draftsmen made an error, but regarding the castings he can get them for 2.7 cents per pound and with planing at 4.80 cents per pound.

‡ On this point Mr. Edison repeats that his plan does not provide for isolated houses.

On the subject of molds Mr. Larned writes as follows: "I note in my statement of the size of the building that Mr. Edison gives the height as 35 feet not including the cellar, whereas I supposed it did include the cellar. With this correction it becomes necessary to revise the estimate of the weight of the molds and I find on a recomputation that instead of 450,000 pounds, they will weigh 530,000 pounds. This, of course, affects not only the cost of the molds but the cost of erection, removal and transportation, adding for railroad shipment four additional cars.

"I also desire to call attention to the fact that I have made no comment upon the fact that Mr. Edison apparently makes no provision for outside or inside staging to assist and facilitate the erection of the molds. In my judgment they cannot be erected without the use of staging and this introduces another element of cost which has been entirely omitted in my figures."

* Concerning the table of costs Mr. Edison states that actual construction will show how accurate are the figures given. As to the cost of transportation, etc., he says: "Suppose several hundred houses were erected at this spot, what becomes of the criticism on cost of transportation?"

† This conclusion Mr. Edison insists is wrong.

‡ Mr. Edison takes exception to this statement, adding that there is variety in colloids.

The addition of a colloid is also expected to render the concrete impermeable and make unnecessary any other waterproof treatment. Mr. Edison also believes that because of the low conductivity of concrete, no difficulty will be experienced from condensation of the inside of the walls, and it is proposed to leave the inside surfaces produced by the mold plates without further treatment, unless tinting be desired for purposes of decoration. It is also interesting to note that no joint will be provided to take up contraction and expansion.

The use of plungers, power driven, to keep the concrete agitated and assist in its flow, is a very novel feature, and results will be observed with much interest. It would seem that plungers large enough to be effective would subject the molds to considerable strain, and if the effect is violent enough to cause quick or unusual motion in the concrete, it suggests the possibility of the displacement of reinforcement, unless the same be very rigidly fixed in position.*

In connection with the proposition to raise the concrete to the top of the building, by means of a bucket elevator, a computation reveals the following interesting facts, viz., if the buckets be of ½ cubic foot capacity each, they must discharge at the rate of 18 buckets per minute to handle 200 cubic yards in ten hours. If of ¼ cubic foot capacity each, they must discharge at the rate of 36 buckets per minute. In either case, this means a belt or chain speed of from 1/3 to 1/2 more in each case, and the loading of the buckets by continuous discharge from the hopper suggests the possible waste of some material and the fouling of the chain or belts to an extent that would probably cause some trouble. It would be impractical to load the buckets full of such fluid material owing to waste.*

Mr. Edison has, undoubtedly, taken a bold step in the right direction, and the new ideas that are set in motion by his experiments will doubtless evolve a scheme by which the cost of the forms will be materially reduced, and the time required for construction greatly shortened.

* On this point Mr. Edison states that the area of agitation cannot extend more than three feet.

* This Mr. Edison answers with the statement that the buckets can overflow. The elevator has a back to permit spills to flow back to the reservoir.

WHAT FORESTRY HAS DONE.

THE NEED OF THE PRESERVATION OF OUR TIMBER SUPPLY.

MANY people in this country think that forestry had never been tried until the government began to practise it upon the national forests. Yet forestry is practised by every civilized country in the world except China and Turkey. It gets results which can be got in no other way, and which are necessary to the general welfare.

What forestry has done abroad is the strongest proof of what it can accomplish here. The remarkable success of forest management in the civilized countries of Europe and Asia is the most forcible argument which can be brought in support of wise forest use in the United States.

The more advanced and progressive countries arrive first and go farthest in forestry, as they do in other things. Indeed, we might almost take forestry as a yardstick with which to measure the height of a civilization. On the one hand, the nations which follow forestry most widely and systematically would be found to be the most enlightened nations. On the other hand, when we applied our yardstick to such countries as are without forestry, we could say with a good deal of assurance, by this test alone, "Here is a backward nation."

The countries of Europe and Asia, taken together, have passed through all the stages of forest history and applied all the known principles of forestry. They are rich in forest experience. The lessons of forestry were brought home to them by hard knocks. Their forest systems were built up gradually as the result of hardship. They did not first spin fine theories and then apply those theories by main force. On the contrary, they began by facing disagreeable facts. Every step of the way toward wise forest use, the world over, has been made at the sharp spur of want, suffering, or loss. As a result, the science of forestry is one of the most practical and most directly useful of all the sciences. It is a serious work, undertaken as a measure of relief, and continued as a safeguard against future calamity.

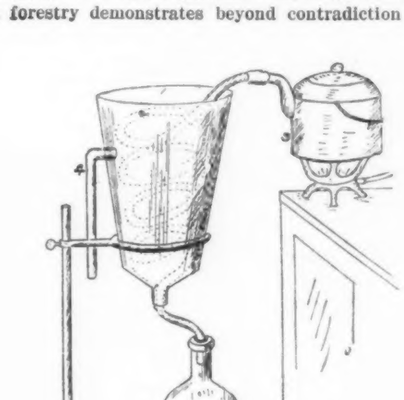
The United States, then, in attacking the problem of how best to use its great forest resources, is not in the position of a pioneer in the field. It has the experience of all other countries to go upon. There is no need for years of experiment with untried theories. The forest principles which hundreds of years of actual practice have proved right are at its command. The only question is, How should these be modified or extended to best meet American conditions? In the management of the national forests the government is not working in the dark. Nor is it slavishly copying European countries. It is putting into practice, in America, and for Americans, principles tried and found correct, which will insure to all the people alike the fullest and best use of all forest resources.

Take the case of Germany. Starting with forests which were in as bad shape as many of our own which have been recklessly cut over, it raised the average yield of wood per acre from 20 cubic feet in 1830 to 65 cubic feet in 1904. During the same period of time it trebled the proportion of saw timber got from the average cut, which means, in other words, that through the practice of forestry the timberlands of Germany are of three times better quality to-day than when no system was used. And in fifty-four years it increased the money returns from an average acre of forest sevenfold.

In France forestry has decreased the danger from floods, which threaten to destroy vast areas of fertile farms, and in doing so has added many millions of dollars to the national wealth in new forests. It has removed the danger from sand dunes and in their place has created a property worth many millions of dollars. Applied to the state forests, which are small in comparison with the national forests of this country, it causes them to yield each year a net revenue of more than $4,700,000, though the sum spent on each acre for management is over 100 times greater than that spent on the forests of the United States.

France and Germany together have a population of 100,000,000, in round numbers, against our probable 85,000,000, and state forests of 14,500,000 acres against our 160,000,000 acres of national forests; but France and Germany spend on their forests $11,000,000 a year and get from them in net returns $30,000,000 a year, while the United States spent on the national forests last year $1,400,000 and secured a net return of less than $130,000.

In Switzerland, where every foot of agricultural land is of the greatest value, forestry has made it possible for the people to farm all land fit for crops, and so has assisted the country to support a larger population, and one that is more prosperous, than would be the case if the valleys were subjected to destructive floods. In a country as small as Switzerland, and one which contains so many high and rugged mountains, this is a service the benefits of which cannot be measured in dollars. It is in Switzerland also, in the Sihlwald, that forestry demonstrates beyond contradiction how great a yield in wood and money it may bring about if applied consistently for a number of years.



A SIMPLE HOME-MADE STILL.

A circular entitled "What Forestry Has Done," just published by the Forest Service, and obtainable upon application to the Forester, Washington, D. C., reviews the forest work of the leading foreign countries. The chief lessons which may be learned from them are summarized as follows:

What forestry has done in other countries shows, first of all, that forestry pays, and that it pays best where the most money is expended in applying it. The United States is enormously behindhand in its expenditure for the management of the national forests, but nevertheless returns have already increased with increased expenditure for management.

A second lesson, clearly brought home by foreign forestry, is the need of timely action, since forest waste can be repaired only at great cost.

Third, private initiative does not suffice by itself to prevent wasteful forest use. England, it is true, has so far consistently followed a let-alone policy. However, England has been depending upon foreign supplies of wood. Now that all Europe is running behind every year in the production of wood (2,620,000 tons), and there are unmistakable signs that countries which lead as exporters of wood will have to curtail their wood exports, England is at last feeling her dependence and is speculating uneasily as to where she can certainly secure what wood she needs in the future.

Fourth, when the forest countries are compared as to wood imports and exports, and when it is realized that a number of the countries which practise forestry are even now on the wood-importing list, the need of forestry in the export countries is doubly enforced.

Russia, Sweden, Austria-Hungary, and Canada, for instance, are making good the wood deficit of a large part of the world. Sweden cuts much more wood (106,000,000 cubic feet) than she produces; Russia, in spite of her enormous forest resources, has probably entered the same road; and England, the leading importer of wood, must count more and more on Canada. But the United States consumes every year from three to four times the wood which its forests produce, and in due time will doubtless take all the wood that Canada can spare. In other words, unless the countries of the western hemisphere apply forestry promptly and thoroughly, they will one day assuredly be held responsible for a world-wide timber famine.

Fifth, in comparison with foreign countries, the prospects for forestry in the United States are particularly bright, for the following reasons:

1. We start with the assurance that success can certainly be attained.

2. We have few of the handicaps which have trammeled other countries. We have no ancient forest rights and usages with which to contend, or troublesome property questions to settle.

3. The results which other lands have achieved by long struggle, often with bitter costs, are free to us to use as we wish. We have, it is true, our purely national and local forest questions, but the key to many of them is somewhere in the keeping of the countries which have achieved forestry.

4. In variety combined with value our forests are without a parallel in the world. They produce timber adapted to the greatest variety of uses, so that, except to meet shortage, importations of wood are unnecessary. Furthermore, transportation facilities enable us to make every forest region available. Thus, by specializing our forest management, each kind of forest may be made to yield the kind of material for which it is best adapted, and the wastes due to compulsory use of local supplies may be practically eliminated.

HOME-MADE WATER STILL.

By L. W. MARSHALL.

FOR producing distilled water in small quantities, I have designed a still which consists of a tin percolator, 1, a coil of pipe, 2, and a tea kettle, 3, or other suitable vessel. The percolator has a hole cut near the top to which a tin tube, 4, is soldered, in order that the water from the ice may pass off.

To use this still, fill the percolator with cracked ice and attach the upper end of the pipe to the spout of the kettle in which the water is to be boiled. The lower end of the pipe should fit the neck of the percolator tight, so that the water from the melting ice cannot contaminate the distilled water in the receptacle underneath.—Druggists' Circular.

A patent has been taken out for a process of manufacturing calcium carbide, according to which the molten substance when tapped from the furnace is poured into molds coated internally with finely-powdered coke, wood charcoal, or lampblack. The idea of the invention is that the semi-fluid carbide shall react with the carbon, the excess of lime present in the substance as it leaves the furnace being thereby decomposed and a corresponding quantity of fresh carbide being formed. It is stated that under the conditions mentioned the reaction proceeds so violently that the liberation of the oxygen causes the carbide to effervesce or boil.

SOME SNAKES AND OTHER REPTILES.

SOME PERSONAL OBSERVATIONS.

BY RAYMOND L. DITMARS.

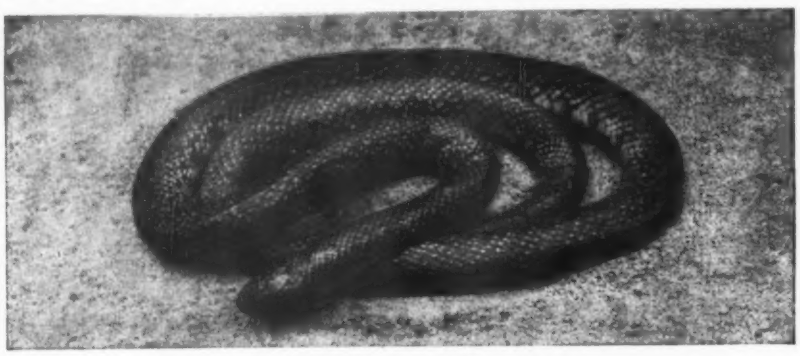
Reptiles in general, and snakes in particular, occupy a low position in human estimation. No doubt the poison apparatus of some of the snakes is chiefly responsible for this; and there is a feeling, too, that many reptiles are repulsive in appearance. But if prejudice is laid aside, reptiles prove to be most interesting creatures, and by no means deserving of a general condemnation. Even the poisonous snakes, judged by the few fatal accidents in connection with them, are comparatively innocuous; and the widely feared alligator has so wholesome a fear of man that if a bather enters his water the reptile at once moves a substantial distance away.

A valuable book on the reptiles of the United States has recently been published.* The author, Raymond L. Ditmars, is curator of reptiles at the New York Zoological Park, where he has had exceptional opportunities of studying the creatures he writes about. By the courtesy of the publishers we reproduce several illustrations from its pages, and quote parts of the text.

There are 254 species of reptiles known in the United States, of which 111 are snakes, and 97 are lizards. Tortoises and turtles account for 44, and the remaining two are crocodilians—the alligator and the American crocodile. The snakes are not only the most numerous, but they loom largest in the popular eye; and among them the rattlesnake is pre-eminent on account of its capacity for inflicting fatal injury, and the romance of its rattle. We speak of the "rattlesnake," but there are thirteen species of them in the States, ranging from the Pigmy, of which an 18-inch specimen is a large one, to the Diamond-back—a formidable monster sometimes growing to 8 feet. These extremes of the rattlesnake world, by the way, are both found in the Southeastern States.

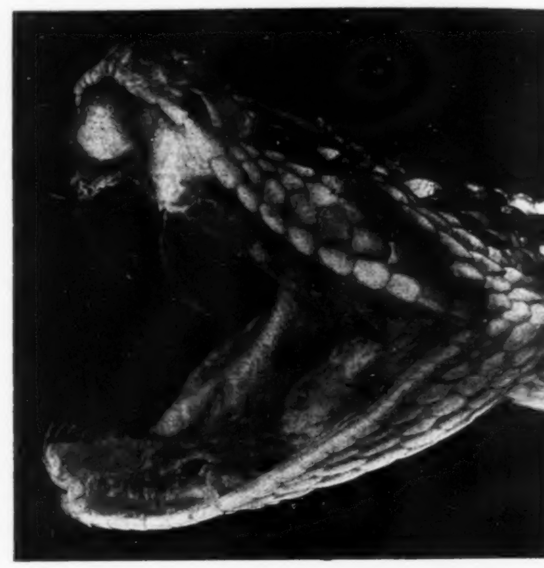
In spite of the deadliness of its venom, deaths from rattlesnake bites are so rare that the occurrence of one is considered worthy of a first page display head in newspapers throughout the country. There are several reasons for this. American people do not walk bare-footed in snakes' haunts (as they do in India, where the recorded fatalities reach 22,000 annually); and the snakes are most commonly found in spots seldom visited by man. On the approach of danger they usually contrive to glide away, and if cornered they give warning with their rattles, and are content to fight on the defensive.

The poison apparatus of rattlesnakes consists of two long and hollow fangs with an elongated orifice at their tips for the ejection of venom. The fangs are rigidly fastened to a movable bone in the upper jaw, and each connects with a gland, situated behind the eye, and containing the venom. When the jaws are closed, the fangs fold back against the roof of the mouth. As the jaws are opened they spring forward, ready for action. The ejection of venom from the fangs is caused by the contraction against the glands of the muscles which close the jaws. The fangs are shed at intervals of about three months, and a new fang grows into place and becomes connected with the poison bag, before the old fang loosens. The old fang is shed by being left imbedded in the body of the prey that is bitten by the snake, and is consequently swallowed with it. This constant renewing of the fangs explodes the common supposition that a poisonous snake may be rendered harmless by their removal. When the snake strikes it stabs rather than bites, and the moment the blow is delivered it draws back to a position of defense. The idea of a snake's "darting from its coil" and projecting its entire length through the air is quite wide of the truth. At most, the snake strikes about one-half its length when delivering an accurately-aimed blow; not unless goaded into a frenzy will it strike two-thirds its length, and



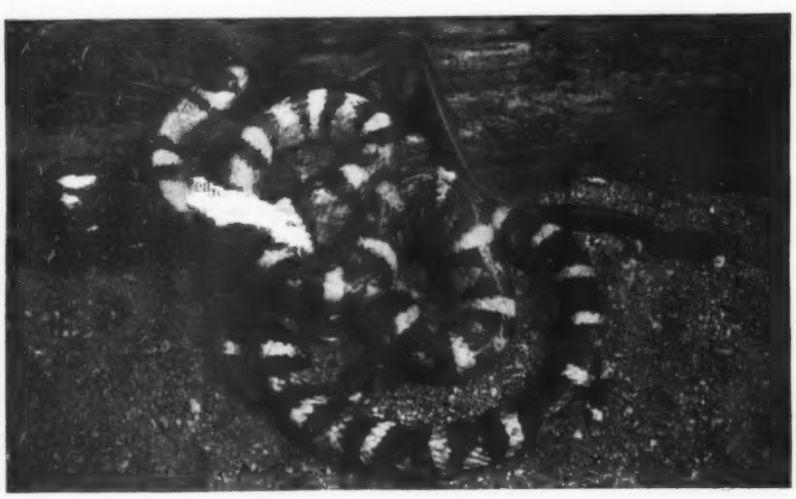
SAY'S KING SNAKE, OPHIBOLUS GETULUS SAYI.

Found in the lower portion of the Mississippi Valley and is remarkable in having a light green spot in the center of each scale.



HEAD OF RATTLESNAKE.

When the jaws are closed the fangs fold back against the roof of the mouth. They are exactly like the hypodermic needle—having an elongated orifice at their tip for the ejection of venom. The opening near the front of the lower jaw shows the location of the tongue-sheath. Thus it should be understood that the forked tongue is not a sting or in any way connected with the poison apparatus.



ARIZONA KING SNAKE; RINGED SNAKE, OPHIBOLUS ZONATUS. FROM ARIZONA.

Two distinct phases inhabit Arizona and California respectively. The colors are scarlet, yellow, and black, arranged in rings. On the Arizona phase the black predominates.

SKULL OF A PIT VIPER, SHOWING DEVELOPING FANGS.

The illustration shows how fangs are constantly developing to take the place of the functional pair.

ARIZONA RINGED SNAKE; KING SNAKE, OPHIBOLUS ZONATUS. SOUTHERN CALIFORNIA.

The California phase is regularly ringed and the most beautiful snake found in the extreme West.

SOME SNAKES AND OTHER REPTILES.

* The Reptile Book: Snakes, Lizards, Crocodiles, Turtles, and Tortoises. New York: Doubleday, Page & Co. Price, $4 net.

such blows are uncertain in aim. To spring bodily at its enemy is physically impossible.

A bite from a poisonous serpent is a serious affair; and in case of accident, apart from such remedies as are carried by snake hunters or people who anticipate trouble from snake bite, the method to be adopted is first to apply a ligature, and then to cut across the wound with a very sharp knife, making a gash an inch long, slightly deeper than the fang mark. The flow of blood should be accelerated if possible by suction with the mouth; and a surgeon should be reached at the earliest moment. The author has little faith in most so-called cures—including whisky. There are many harmless snakes, and the bite from one of these, magnified by fear into a dangerous wound, has driven many a man to temporary excess, and incidentally given him a thrilling story for the rest of his life. It may be quite true that a man who drinks whisky under such conditions may imbibe an abnormal amount without becoming intoxicated; but this is the result of abject fear—not snake venom. As a matter of fact, an excessive dose of whisky would numb the body, and render it more vulnerable to the attack of the poison.

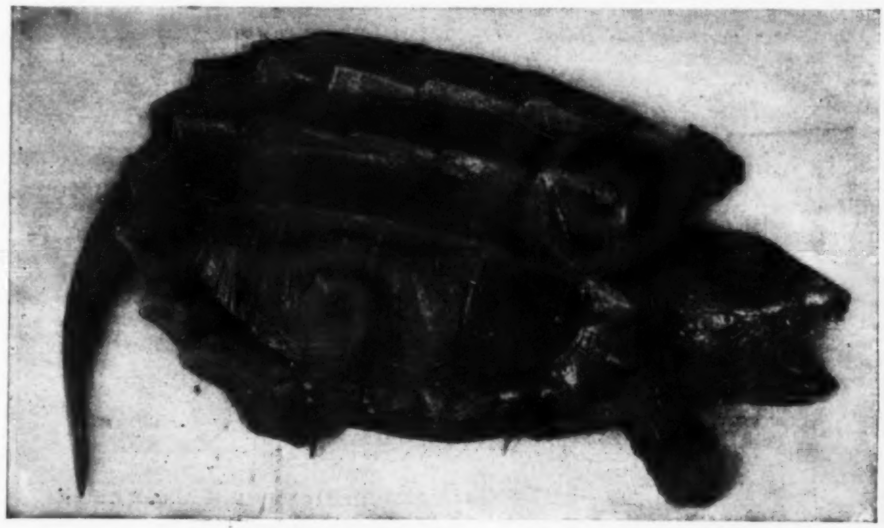
According to a popular belief, the rattlesnake possesses as many rattles as it has lived years. This is quite erroneous; the snake acquires from two to three rings of the rattle each year—usually three, and sometimes, though rarely, four segments. The rattle seldom attains a length of more than ten or eleven rings, as when that number has been acquired the vibration at the tip, when the organ is used, is so pronounced that the old segments are soon worn, broken, and lost.

While it is true that the greater number of snakes are not injurious to man, it cannot be said that many of them are positively useful to him. The food of many species consists largely of frogs or toads, creatures not hurtful to the farmer. Among the useful snakes may be classed the king snakes, a genus which includes the common milk snake of the East. This little reptile is innocent of the charge of milk stealing which is commonly brought against it. It is fond of prowling round stables and dairies, but it is not searching for anything more compromising than mice or young rats. This diet of young rodents, which is shared by all the king snakes, makes them of economic value to the farmer. They have another useful feeding habit: they evince a marked inclination toward cannibalism, and prey frequently upon snakes other than their own species, among their victims being poisonous serpents. In their fights with the latter they are often bitten, but appear to be quite immune to the action of snake poison. It is this snake-eating trait which has earned them the name of "king" snake; though it is not true, as generally alleged, that they are the sworn enemies of poisonous serpents. They are quite as ready to eat a harmless as a poisonous snake.

Snakes are noted for their capacity for swallowing objects larger in girth than themselves; they are voracious feeders at times, but in captivity have been known to spend months without touching food—apparently sulking. This is exceptional, however, for most snakes soon become tame in captivity. Some species of snakes deposit eggs, but others are viviparous, and the young are quite able to fend for themselves at birth. The number of young varies in different species from about half a dozen to fifty or more. A common garter snake has been known to give birth to fifty-four young at one time; and several of the water-snakes are equally prolific. Young snakes are curiously large compared with their parents. A captive copperhead, thirty inches in length, gave birth to six young ones, ten inches long. The eggs laid by some oviparous snakes increase in size as the embryo grows in them until the eggs just before hatching may have grown to almost twice their size when newly deposited. The shells of these eggs are leathery without the hard lime covering of a bird's egg.

A curious feature in young copperheads is the presence, when born, of brilliant sulphur-yellow tails; and these tails frequently wriggle or twist in a manner remarkably suggestive of yellow grubs or maggots. As the young snake, when hidden among dry leaves, is almost indistinguishable from them, it has been suggested that this noticeable appendage is used as a decoy for unsuspecting wood-frogs, who hop toward the "maggot" and fall into the waiting jaws. Whether this be so or not, there is one reptile which makes effective use of a maggot decoy, in this case placed in the mouth; this is the alligator snapping turtle. This giant among turtles has been known to attain a maximum weight of 140 pounds, with a length of shell of about 28 inches. It haunts rivers flowing into the Gulf of Mexico, including of course the Mississippi, where it is common. In appearance and actions it is an enlarged duplicate of the common snapping turtle. Its pale brown hues well match the soft muddy bottoms on which it lies motionless, angling for fish with the decoy referred to. This is attached inside the lower jaw, close to the tongue, and is a well-developed filament of flesh, white and distinct from the yellowish mouth part, and closely resembling a large grub. While waiting the turtle keeps this "grub" in motion, giving it the aspect of crawling about in a small circular course. Its mud-colored shell, often studded with a growth of fine, waving moss, looks like a great round stone, and close to it is a second smaller stone—the head. Close to this smaller stone crawls the plump white grub. A fish sees it and makes a natural mistake, only to be seized with a sudden snap of the powerful jaws. These jaws are wonderfully strong; the common snapper, which attains only a third the size of his larger relative, will bite a finger clean off; and the alligator snapper could bite through a wrist or a foot. One has been known to cut a length from a broom handle with one clean snap.

Students are often puzzled in their attempts to identify specimens of snakes. This is little to be wondered at, for experts themselves fail to agree, some desiring to multiply species, basing their classi-

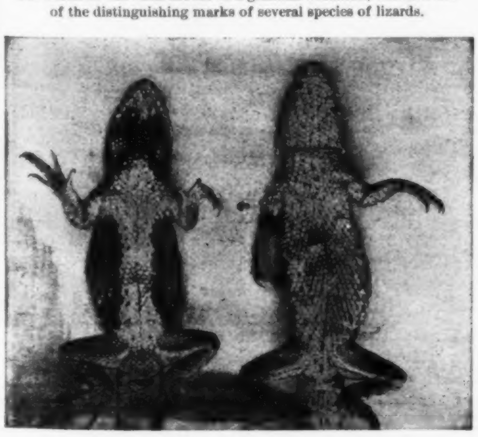


ALLIGATOR SNAPPING TURTLE, MACROCHELYS LACERTINA.

Distinguished from the common snapping turtle by the absence of broad plates under the tail, the yellowish color, and much larger size. Reaches a weight of 140 pounds. Inhabits rivers emptying into the Gulf of Mexico.

LIZARDS OF THE GENUS UTA.

The scales of the back are set in a granular scalation, which is one of the distinguishing marks of several species of lizards.

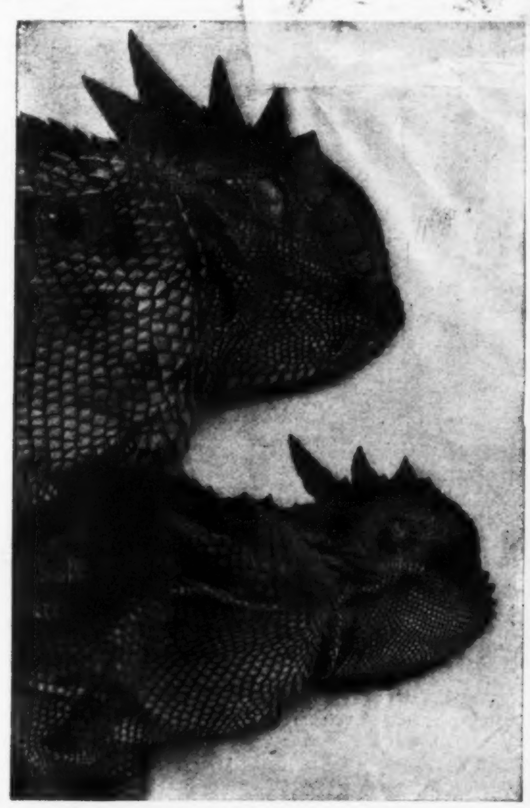


SCELOPORUS UNDULATUS, MALE AND FEMALE.

The large blotches on the abdomen of the male are brilliant blue. This characteristic is to be seen among most of the species of Uta and Sceloporus.

HEADS OF LIZARDS OF THE GENUS SCELOPORUS.

The scalation over the eyes is a valuable aid to identification.



HEADS OF HORNED LIZARDS.

On the lower figure the ear drum is covered with a granular scalation, a character to be looked for in identification.

SOME SNAKES AND OTHER REPTILES.

fications on external markings; while others prefer to group several specimens showing differing markings as varieties of one species. A striking example of this difficulty is shown in the illustrations. The king snakes are noted for their vivid coloring, and the most beautiful species of the genus is the Arizona ringed snake. This snake is found both in Arizona and Southern California, and the illustrations show how widely the varieties from the two localities differ. That even the genus cannot be told by a superficial appearance is shown by the illustration of Say's king snake, which in spite of close relationship has a very different appearance. In identifying snakes, whether from known specimens or from printed pictures or descriptions, the student should pay especial attention to form, whether stout or slender, the outline of the head, and the proportionate length of the tail. He should notice the placing and formation of the scales; on what rows of scales stripes appear, and the character of any spots. Much can be learned by elimination. Thus, if a snake is found six feet long, all the smaller species may be ignored in the identification, and the locality in which it is captured will also limit the possible species. Rattlesnakes can be distinguished from other snakes, and the snake which loves arid sand from the one which haunts the water. So that with care even a novice may, with the assistance of a good description, place a snake in its correct genus, and in the majority of cases rightly name the species.

Lizards, as species, are almost as numerous as snakes in the United States, but they are much less in evidence. There is a widespread but rather nebulous belief that lizards are poisonous, but there is only one species that is so—the Gila monster. Among

quiver upward from the bleached soil they prepare for the night. This is a curious process. The lizard imbeds its nose in the sand like the blade of a plow, and then quickly works its way forward a few inches, scooping vigorously with its head to produce a furrow. Thus having worked its way a little distance into the sand it flattens its body, and employing alternately its head and the sharp spiny borders of its sides, digs its way deeper and deeper and casts the sand over its back until it is entirely covered.

As in the case of snakes, a student may usually place a lizard in its correct genus without much difficulty. More than one-third the total number of American species are either horned lizards or swifts—the latter being subdivided into two genera. The horned lizards may be readily distinguished from the swifts; and of these one genus (Sceloporus) has large, coarsely keeled, and sharply pointed scales over the entire upper surface. The other genus (Uta) has the greater area of the back and sides covered with very small scales, though some species have enlarged rows of scales on the central portion of their back. An illustration of typical representatives of the genus Uta plainly shows the characteristic scalation which may be compared with the rough pointed scales shown on the neck in the illustration of heads of Sceloporus.

As an example of the points over which experts agree to differ, two heads of horned lizards are shown. The ear drum of several species is covered with a thin skin, studded with minute scales. Taking note of this some writers have divided horned lizards into two genera; while others prefer to class them in one.

Reptiles do not deserve the contempt or dislike which is shown to them, and particularly to snakes.

HEAD OF THE ALLIGATOR TURTLE, MACROCHELYS LACERTINA.

The jaws of a large specimen could readily amputate a man's hand or foot.

SOME SNAKES AND OTHER REPTILES.

the most curious of the lizards is that very distinct Western genus, the horned lizard—usually called the horned toad. These creatures are lizards, but in several ways they are so toadlike that the popular name may be readily appreciated. Their method of feeding is much like that of the toad, a condition strengthened by the character of the tongue. The horned lizards do not procure their prey by a scampering rush as do the majority of the North American lizards. On coming near the food the head is bent deliberately, the thick, viscid tongue is quickly protruded and like a flash the morsel has disappeared within the lizard's mouth. Although these actions are very toadlike, all similarity in movements may be dispelled a few seconds later, when the lizard, taking fright, darts away with the speed of a startled mouse.

Their very wide, much flattened, toad-like bodies, the short tail, and the development among most of the species of sharp conical horns upon the back of the head and the temples are unique features. The scalation is also peculiar, as the back is covered with minute, granular scales, among which rise, almost vertically, greatly enlarged and pointed scales, like miniature pyramids. Altogether, these lizards are so spiny in their general make-up as to appear quite formidable to the uninitiated observer. They are creatures of hot and dry, sandy or sub-arid situations. Many of the species inhabit the desert proper where the sun, beating without obstruction upon ground destitute of moisture, produces a heat practically unendurable to man. In the burning wastes of the Southwest they dart here and there with wonderful rapidity, subsisting entirely upon insect life. When the sun is at its highest they display the most vivacity. Long before the sunset, while the heat-waves yet

In their own haunts they seldom intrude on man; on the contrary, when surprised their one desire is to escape. In captivity they make interesting pets. Many species soon grow tame, and will live for years; and as they do not share with most pets the need for frequent or regular meals, they may be kept with a minimum of trouble.

THE SEVEN WONDERS OF THE WORLD.

By F. M. Feldhaus.

The number seven has always played a prominent part in human life. Hence it is not surprising that seven, and only seven, monumental structures were included in the ancient Greek catalogue of the wonders of the world. The catalogue has been handed down to us by tradition, but the works themselves, with the exception of the Pyramids of Egypt, have either vanished from the face of the earth or exist only as ruins.

The fame of the Seven Wonders of the World appears to have rested upon their hugeness (real or alleged) and the oddity of their forms and construction. A finer taste, less easily dazzled by externals, would have selected for admiration objects very different from the Egyptian Pyramids, the Hanging Gardens of Semiramis, the temple of Diana at Ephesus, the statue of Jupiter at Olympia, the Colossus of Rhodes, the Pharos at Alexandria, and the Mausoleum at Halicarnassus. With the exception of the Pyramids, the most ancient of all, these structures were products of decadent civilizations, and the description of them conjointly as the Seven Wonders of the World was also made in an age when taste and genius were on the decline. The earliest known attempt to picture them was made in the seventeenth century, after scientists, travelers and artists of the Renaissance had furnished material for plausible reconstruction. The remarkably versatile Jesuit missionary Athanasius Kircher was born near Fulda in 1601. He traveled far and wide and wrote a goodly number of great folio volumes, illustrated with excellent copper plate engravings. He was especially fond of describing and depicting the wonderful and mysterious. Among the subjects of his books are the Seven Wonders, Noah's ark, obelisks, the interior of the earth, light, and magnetism. His opinions, imposed on his contemporaries by his great personal authority, have been accepted without question until very recently.

The Seven Wonders have enriched modern languages with a number of words—mausoleum, colossal, pyramidal—and the expression Herostratic fame, derived from Herostratus, "the aspiring youth who fired the Ephesian dome."

The Pyramids were built more than four thousand years ago, as monumental tombs of Egyptian kings. Most of them, including the largest, stand in lower Egypt near the west bank of the Nile, where the ruins of sixty-seven similar structures have been found buried under a pall of sand. The largest is the Pyramid of Cheops or Chufu. It was originally 233 meters (764 feet) square at the base and 146.5 meters (480 feet) high, but the length of each side is now reduced to 227.5 meters (746 feet) and the height to 135.2 meters (443½ feet).

Piazzi Smyth, late astronomer royal for Scotland, and a publisher named Taylor discovered a number of wonderful things in the dimensions of the Pyramid of Cheops, for example, that the height bears the same ratio to the periphery of the base that the radius of a circle bears to its circumference (the ratio 3.14159, denoted by the symbol π). Hence these ingenious investigators inferred that the Egyptians of 4,000 years ago knew the value of π to the fifth decimal place. They found the length of the side of the base equal to one ten-millionth part of the radius of the earth, the height equal to one thousand-millionth part of the distance of the earth from the sun, and obtained a unit of length by dividing the length of the base by the number of days in a year. These discoveries were taken to indicate that the Egyptians knew, long before the time of Pythagoras, that the earth is spherical, and knew its radius and its distance from the sun with greater accuracy than Copernicus or Kepler did!

It is certain, however, that the inclined passage which leads to the interior of the pyramid would, if extended outward, meet the sky very near the point which marked the position of the Pole star 4,000 years ago. . ence the lines of the plan were directed by the stars.

The British investigators also discovered in the Great Pyramid the correct value of the density of the earth and found that its mass was equal to that of the earth divided by 10^{15}. Hence they concluded that it was designed to serve, not as a tomb, but as an eternal record and monument of scientific discoveries and standards of measurement. But as the oldest known mathematical treatise, the Rhind papyrus, written about 1500 B. C., contains only the merest rudiments of arithmetic, it is not likely that the Egyptians were familiar with advanced mathematics a thousand years earlier.

The Hanging Gardens of Babylon, which were supposed to have been constructed by the more or less fabulous queen Semiramis, owe their celebrity to the fantastic descriptions given by Roman and Greek writers. Recent excavations have shown the gross exaggeration and fictitious embellishments of these accounts. The mighty Babylon of the classic authors has shrunk to one-fiftieth of its traditional area as a result of thorough study of the cuneiform inscriptions. The immensely high and thick walls, with their hundred gates, appear to have been largely works of the imagination. Yet it is not surprising that Greek merchants and other travelers, visiting the ancient metropolis on the Euphrates in the fifth and sixth centuries before our era, were amazed by the size and wealth of the city and the magnificence of its palaces and other buildings, nor is it surprising that they embellished the stories which they carried home. Recent explorers claim to have found the Hanging Gardens of Semiramis in the ruins of the third palace of Nebuchadnezzar, who reigned from 605 to 561 B. C. This palace or garden stood on a broad platform supported by foundation walls 100 feet in height, the ruins of which lie buried in the hill called Babil just within the north wall of the city. An inscription of Nebuchadnezzar informs us that the third palace was erected "where the brick wall meets the north wind." Rassam claims to have found remains of wells or shafts, through which water was raised to the terrace. The bricks of this royal palace are now being used in building a dam across the Euphrates.

Interesting in this connection are the words of Frontinus, who superintended the construction of the great aqueducts of Rome, 1,700 years ago: "Can one compare with these wonderful aqueducts, which supply so many needs of humanity, the useless pyramids and other famous structures?"

On the night when Alexander the Great was born,

In the year 356 B. C., a youth named Herostratus set fire to the Temple of Artemis, or Diana, at Ephesus, with the avowed object of making his name immortal. He was put to death and it was decreed that his name should be omitted from the records. But his name was rescued from oblivion and so his longing for posthumous fame has been gratified. The temple, the erection of which had occupied 120 years and cost a fabulous sum of money, was rebuilt after the conflagration by the united efforts of all the princes of Asia Minor on so magnificent a scale that it continued to be reckoned among the Seven Wonders. It was four times as large as the Parthenon at Athens, glittered with gold and gems, and contained 127 columns, adorned with reliefs, in honor of the 127 princes who had impoverished themselves—or their subjects—in its construction. The fame of Diana of the Ephesians is attested by the New Testament. The restored temple was destroyed by Constantine and even its ruins have entirely vanished.

To the Greeks the ideal image of their principal deity, Zeus, the Latin Jupiter, was the colossal statue at Olympia, the site of their most celebrated national athletic contests. The statue was the work of the famous sculptor Phidias, the friend of Pericles. The seated figure was 40 feet high and was supported by a pedestal 12 feet broad. The nude upper part was of ivory, the draperies of gold, the right hand grasped the globe of the earth, the left the scepter adorned with the eagle. Figures of Victory and dancing Hours and Graces surrounded the throne, which was adorned with numerous figures in relief. According to Strabo, this great statue was housed in a temple so ill proportioned to it that Jove could not have stood up without knocking his head against the roof.

The Colossus of Rhodes was a bronze statue of Apollo, the god of the sun, about 110 feet high, which according to tradition straddled the entrance to the harbor of Rhodes. It was completed, after twelve years' labor, in the year 285 B. C. Fifty years later it was destroyed, with a large part of the city, by an earthquake, and its reconstruction was prohibited by an oracle. When the Arabs conquered the island of Rhodes in the seventh century the Mohammedan commander sold the remains of the Colossus to a Jew from Edessa and 900 camels were laden with its fragments.

The most renowned of the few lighthouses of antiquity was one erected, according to tradition, in 283 B. C., on the little island of Pharos in the harbor of Alexandria. Its height is given as about 560 feet, its cost as 800 talents, equivalent to $90,000. The Pharos was standing at the beginning of the fourteenth century. It has since been destroyed, but the time and manner of its destruction are unknown.

The list of the Seven Wonders, which began with the Pyramids, ends with another royal tomb, the Mausoleum at Halicarnassus. This monument was erected about 350 B. C., by Mausolos, king of Caria in Asia Minor, in honor of his deceased consort Artemisia. It was 164 feet high and nearly 500 feet in circumference at the base. Its broad and lofty dome was supported by many columns and surrounded by a colonnade. The building was overthrown by an earthquake in the thirteenth century and its ruins furnished the Knights of St. John with material for the construction of a castle.

All of the Seven Wonders were situated on the shores of the eastern part of the Mediterranean. If the Greek writers had been better acquainted with the north of Europe or the south of Asia they would probably have made a different selection. Near Salisbury in England, for example, stand the cyclopean remains of the very ancient temple of the sun, which are known as Stonehenge, and near Delhi in India stands a huge consecrated column of iron, the casting of which would tax the resources of the best of modern foundries.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Gartenlaube.

THE HABITABILITY OF MARS.

A REPLY TO DR. ALFRED RUSSELL WALLACE.

BY PERCIVAL LOWELL.

INASMUCH as Dr. Wallace has sent me his book through his publishers, I suppose it is incumbent on me to acknowledge it, since he clearly expects some sort of reply. The effect of its perusal is to show me again how cogent is the argument for the habitability of Mars, for only by many misstatements of fact, wholly unintentional, of course, can Dr. Wallace make out even a seeming case upon the other side. A physicist will not need to have these errors pointed out to him, but as most readers are unable to correct them for themselves it may be wise to instance a few to show how his house of cards tumbles down in consequence.

On page 22 he quotes from Miss Clerke to prove that the cap could only supply 2 inches of water over the irrigated districts. Let us assume her own estimate of snow deposited, and merely correct her mathematical and topographical mistakes. She states the maximum area which the cap covers to be 2,400,000 square miles. Now the south cap comes down to 36.5 deg. latitude on the average, and an easy calculation shows this to occupy 11,330,000 square miles, or to be more than four times as great. Next she supposes the natural dark areas of the planet to be irrigated, which they are not, mistaking them for the canal system, which, instead of 17,000,000 square miles, covers, oases and all, only about 4,750,000 according to our measures, remembering that the whole of it is not watered from one cap. By combining these two corrections we find, not 2 inches of water for each bit of ground, but 2¼ feet, and this, according to her own estimate, which there is no reason to suppose not to be two or three times too small. So that it is the argument of Dr. Wallace, and not the cap, that fails to hold water.

An equally fatal flaw affects Dr. Wallace's argument for temperature. Here he bases his deduction on a misstatement of Prof. Poynting. Prof. Poynting states that in my paper on the mean temperature of Mars I took no due account of the blanketing effect of air. Not only did I expressly take it into account, but I did so in the only way it can correctly be taken, not by hypothesis, but by direct appeal to what takes place on earth under a clear and under a cloudy sky by night; and I am glad to know that in a paper he has sent to the Phil. Mag. on the subject Prof. Very, the bolometric authority on matters of temperature to-day, agrees with both my method and my conclusion for Mars, and points out where Prof. Poynting's calculations are fallacious.

Another omission is no less telling. Dr. Wallace apparently is unaware that Prof. Very's bolometric determination of the moon's heat, which for delicacy surpasses any previous ones, makes the temperature on the moon during the lunar day reach 356 deg. F. above Fahrenheit zero.

Many more such misunderstandings might be mentioned occurring throughout the book, such as where, from not giving its context, he makes me appear to say that water-vapor is one of the heavier gases, which, of course, I did not.

Again, his theory, taken from Chamberlin, that the interior of Mars can have completely lost its heat in the very process of contraction, and yet later have suffered a meteoric bombardment sufficient to give it a heated outer layer, is mechanically whimsical, not to say impossible. For it can be shown that Mars could not have captured any meteoric swarms not substantially traveling in its own orbit when it coalesced into a planetary mass, and any meteors subsequently encountered would only have fallen on it as it passed through a swarm, yielding a relatively insignificant amount of matter. Any such effect would be even more pronounced on the earth, of the occurrence of which there is no evidence.

Misstatements cannot be too carefully avoided in science, especially when a man, however eminent in one branch, is wandering into another not his own. Dr. Wallace, whose intentions are of the highest, will appreciate this. Indeed, if criticism were confined, as common-sense counsels, to those versed in the phenomena, we should hear very little about the inhabitability of Mars.—Nature.

ELECTROPLATING IN QUANTITIES IN DRUMS.

IN the last few years there have been made quite a number of apparatus for electroplating small articles in quantity. In most of these, the pieces to be plated are placed in rotating drums with perforated walls. The drums are partly constructed of non-conducting materials, and the objects to be plated are held by metal strips, which are put in electric connection with the source of current, in different ways. As such apparatus are now in very extended use, a few hints as to their practical employment should not be out of place.

Almost every one who works for the first time with a drum apparatus experiences more or less trouble therewith. As a rule, the apparatus is not to blame therefor; it is the fault of the operator, who is not familiar with its working. The greatest difficulty in using a drum apparatus is when the tension is not high enough. Ten to fifteen volts are necessary in order that the currents shall flow through the electrolytes in the drum. The reason for this is the resistance which the drum makes to the passage of the current. This is just the same as when a non-conducting substance comes between the anode and the piece to be plated. The current will not flow through the solution; and if this does not take place, no metal will be deposited.

For some kinds of work a six-volt dynamo will suffice; but the results obtained therewith are, however, not especially good; also, the deposit does not take place so rapidly as with higher voltage. In such case only a small number of articles can be placed for plating in the drum. Where there are too many, the deposit takes place too slowly, and with great irregularity. With higher tension, the desired amount of metal is deposited in a short time on the articles.

Of equal importance with the current voltage is the strength of the solution. It is useless to try to electroplate with a weak solution. The resistance of the solution, in combination with that of the drum itself, prevents the passage of the current. For instance, a nickel solution of 5 to 6 degrees Baumé, which is strong enough for ordinary electroplating, is not suitable for drum work. In the latter case, either the articles will not be covered, or only their edges will be plated. If, however, a solution of 8 to 9 degrees Baumé, or a saturated solution, be used, the deposit will be made with success. The same is the case with brass and copper solutions. [illegible] who get the best results with the drum apparatus, always employ [illegible] electrolytes.

The [illegible] speed is of no very great importance. It is only necessary to keep the articles in motion. If the speed is too high, however, the objects have a tendency to fly to the walls of the drum and lie there, where their entire surface is not subjected to the action of the current. Special care must be taken to have all the electric connections perfectly clean and properly arranged. If this is not the case, it will be impossible to pass the necessary current through the solution; and the deposit of the metal will in such case be irregular. The same is to be noted in connection with the drum; the holes or slits therein must be kept free from salt crystals and foreign substances. It is often found that imperfect deposit is caused by stoppage of the holes through which the electrolyte and the current pass.

In plating with copper, bronze or brass, there are no conducting salts which can be added, but none are needed; it is only necessary to have the solution as strong as possible. In nickel-plating, it is recommended to use two conducting salts, as for instance ammonia, with either ammonia sulphate or common cooking salt. These salts increase the conductivity of the electrolytic solution. No definite quantity of these can be mentioned as necessary, but the electrolyte will need only a small quantity of these salts. The usual rule is to take as much as the nickel solution will dissolve.

The surfaces of the anode in a drum apparatus should be large, and so arranged that they surround the drum on all sides. In this manner the solution can work the best. A nickel solution requires constant watching. If the electrolyte is too acid, as is often the case, there must be added, to reduce this acidity, nickel carbonate. Boracic acid is used in the drum apparatus in the same way as with other nickel solutions.

In the regular drum apparatus, bars, chains, etc., cannot be plated with advantage, because, by reason of the rotation of the drum, they bend and tangle so as to make a knot that can hardly be loosened, and the regular plating of which is impossible, and they also may cause short-circuiting in the drum. For such articles special apparatus should be employed, of the so-called swinging type, which do not cause these difficulties. These latter have a half-drum of non-conducting material with a swinging motion, and a fixed anode, and permit the articles in the bath to roll from one side to the other, which prevents tangling.—Deutsche Metall Industrie Zeitung.

ENGINEERING NOTES.

There are two ways of annealing glass, one known as kiln annealing, and the other as lehr annealing. Kiln annealing is a three or four days' process, and lehr annealing takes five or six hours. There is really no difference as far as the strength of the glass is concerned, lehr annealed glass being as strong as kiln annealed glass.

The origin of the establishment of the needle industry in Redditch, which town is now famous for its needle production, is uncertain, but recent researches seem to show that the art of needle making was probably first taught to the inhabitants by the monks of the Cistercian abbey of Bordesley, which was a large religious house existing on the outskirts of the present town of Redditch, and which was dissolved in 1538. The growth of the trade, however, must have been very slow, and it was not until toward the end of the eighteenth century that the bulk of the English needle-making industry was concentrated in and about Redditch.

It is claimed that the Red Jacket shaft in Michigan has the most powerful winding machinery in the world, huge engines of as much as 8,000 horse-power reeling and unreeling drums of wire cable that wind down a straight mile below the surface. These engines wind 10-ton cars of ore one mile at the rate of 40 miles an hour, or from the bottom to the top in 90 seconds. It is claimed that this is the deepest mining shaft in the world. A most interesting feature of the Red Jacket shaft is the theory that it is possible to detect the effect of the earth's revolution in it. President McNair, of the Michigan College of Mines, states that nothing dropped in this deepest of mining shafts can ever reach the bottom without colliding with the east side of the shaft.

In connection with the coaling record recently made by the battleship "King Edward VII," flagship of Admiral Lord Charles Beresford, at Portsmouth by taking in from a collier 1,180 tons of coal in four hours and five minutes—an average of 288.9 tons per hour—an interesting comparison with these figures is afforded by the performances of the German Active Battle Fleet for 1907, which were published in a recent issue of the Marine Rundschau. The best figure for one hour's coaling was the "Wettin's" 425 tons, though her general average was only 185. Next to her came the "Kaiser Wilhelm der Grosse" with 365 tons as her best hour's work, and an average of 181 tons, and then the "Wittelsbach," with 358 tons for the best hour, and the high average for six hours of 222 tons.

It has recently been stated that for the most accurate pyrometry, with temperatures up to 1,600 deg. C., a thermo-element with a potentiometer is the most satisfactory measuring apparatus. Rapidity is secured (*a*) by proper selection and arrangement of the galvanometer; (*b*) by the use of switches to exchange thermo-elements, adjust zero, etc.; and (*c*) by relying upon the galvanometer for as much of the reading as possible so as to minimize potentiometer manipulation. External leakage can be prevented and internal leakage greatly diminished by equipotential shields, which interpose a continuous metallic surface between the circuit and the source of disturbance. Internal leakage also decreases with the resistance of the potentiometer. A slide-wire potentiometer is very undesirable in rapid work, and especially in melting point and calorimetric determinations.

The difficulty of loading bunker coals into vessels when light from the older jetties or staiths has led to the adoption of special apparatus capable of running the coals on the level or on an inclined plane. Coal conveyers have recently been brought into use at the North-Eastern Railway Company's dock at Tyne Dock. The arrangement consists essentially in making the spout into an endless belt conveyer, coals being shipped at low level, and run over the belt in the ordinary way. When shipped into vessels, level with the spout, or above it, the latter is adjusted as may be required, and the belt run by an electric motor, the coals being carried along until they reach the hatch when they drop over into the hold. The belt spout can be adjusted to any angle, but the useful maximum is about 25 deg., and at this angle some 500 tons can be shipped by each conveyer per hour. Some experiments have recently been made on these conveyers, and it was found that the average power working at full load on a slight inclination was 12 horsepower, and the consumption during the test was 7 units, with a total quantity of coal shipped, equal to 410 tons, giving an average per ton of 0.017 unit. While the test was in operation some further experiments to show the power absorbed with various inclinations of the belt were made, with the curious result that a constant absorption of power for any inclination was obtained. Practically the power remained constant at 12 horse-power, and it was found that the belt automatically regulated the quantity of coal carried according to the inclination. This was a result that had never been anticipated.

TRADE NOTES AND FORMULÆ.

To Remove Silver Spots from Fabrics.—(*a*) Moisten the spot with a solution of chloride of copper, until the spot has disappeared, then wash first with hyposulphite of soda and then with water. (*b*) Prepare a solution of permanganate of potash, add hydrochloric acid to it, apply to the spot and then wash it again with hypo-sulphite of soda and finally with water.

Fish Food for Trout and Carp.—Mix 65 parts of meal flour, 3 parts gold pleasure seed or linseed, ground; 2 parts powdered rape seed, 10 parts of maize or beans, crushed; 10 parts of peas, crushed, and 10 parts of grain (preferably wheat), coarsely ground. This mixture is kneaded with 10 parts of common salt and sufficient water into a stiff paste and by means of a syringe, with an opening as large as a lead pencil, spread on a board, strewed with flour, to dry.

Filtration of Bottled Wines.—Filter siphon, with siphon-shaped bent glass tube which in the short leg, at about the height of the bottle, has an egg-shaped enlargement, that is filled with clean cotton wadding. According to the greater or lesser length of the long leg, the suction of the apparatus will be more or less vigorous, while at the same time, the wadding will retain the particles causing turbidity. For repeated use, the wadding is cleansed by boiling out in water and drying.

Elastic Glue-Mass for Molds.—In a roomy kettle, provided with a pouring spout, 10 parts by weight of rain water are poured over 10 parts by weight of glue, and allowed to stand for 24 hours. The surplus water is poured off, the kettle suspended in the water bath and boiled. When the contents are liquefied, 6 parts of crude glycerine and 0.1 part of salicylic acid added and stirred in; strain through a linen cloth into another vessel; when the foam has disappeared, pour slowly, without shaking, into a mold. Smooth off the surface with a playing card, or similar piece of cardboard, allow it to gelatinize, and in 24 hours it is complete. Also about 4 to 5 per cent of bichromate of potash may previously be added. Through this addition, the form in the light will be, to a certain depth, insoluble in water.

Renovation or Restoration of Fat Substances or Fat Vegetable Oils (according to H. Hager).—Over the rancid oil, heated to 95 deg. F., from 1 to 1.25 its volume of 90 per cent alcohol is poured and in the course of half a day vigorously shaken three times, so that each time an emulsive looking fluid is produced. On the following day, the fluid, now divided into two layers, is separated and the oil again shaken up with half its volume of 90 per cent alcohol. This process is repeated according to circumstances three to four times, until the oil treated is pure and tasteless. By distillation, the fatty acids the alcohol has taken up can be separated from it. This method cannot be employed with castor oil, which is soluble in alcohol, nor for cod liver oil, in which the virtue lies in the fatty acids; the same objection applies to croton oil or heavy bay oil.

Waterproof Varnish for Paper.—*a.* Allow gum dammar to stand, with about 4.5 to 6 times the quantity of acetone, about two weeks in a closed bottle at room temperature and pour off the clear solution. To 3 parts of this add 4 parts of thick collodion. Allow to stand until clear. *b.* White shellac, finely pulverized, 30 parts; carbonate of lead, finely powdered, 15 parts; sulphuric ether, 500 parts. Dissolve the shellac in the ether, by allowing it to stand with occasional shaking, filter and then shake in the lead salt. *c.* Dissolve 50 parts of animal glue in 1,000 parts of warm water. Apply warm to the paper and dry. Allow it to lie in a 10 per cent solution of acetate of alumina for 1 hour, dry and smooth. The glue is tanned by this process. *d.* Heat 120 parts of linseed oil varnish in one vessel and simultaneously, in another vessel, mix 33 parts of caustic lime and 22 parts of water. To this add 55 parts of melted India rubber; stir it together and pour it into the heated linseed oil varnish. Stir and strain it and apply hot. *e.* Digest gutta percha with 40 times as much benzine by weight in the water bath carefully, until dissolved. On paper saturated with this varnish, it is possible to write, draw or paint readily.

Removing Spots of Rosin, Tar, Axle-Grease, and the Like.—White goods: Moisten the goods, wipe the spots with a sponge dipped in oil of turpentine, cover them with filter paper and pass a hot iron over them several times, finally wash the goods in warm soap water. Colored cotton and woolen goods: Moisten the goods, spread the spot with grease, soap it in thoroughly, allow the soap a few minutes to act, and wash alternately in oil of turpentine and hot water. If this does not work, cover the spot with yolk of egg that has been mixed with some oil of turpentine and allow it to dry. Scratch off and wash it out thoroughly with hot water. Then finally wash the goods in water to which some hydrochloric acid has been added and rinse out thoroughly in clear river water. Silk, satin, etc.: Wet the goods, wipe the spot with a sponge dipped in a mixture of ether and chloroform. Spread white clay over it, cover it with filter paper and press with a hot iron.

To Remove Spots of Unknown Origin.—White goods and colored cotton goods: Dissolve a small quantity of soap in lukewarm water, add to each quart a teaspoonful of ammonia. Wash the spot with a sponge dipped in the liquid, then wash it out with water. Colored wool fabrics: Dissolve 20 parts of ox-gall, 40 parts of borax in 500 parts of alcohol and 200 parts of ammonia, add 30 parts of glycerine, and the yolks of two eggs; the goods to be washed in this boiling solution. Rinse in clear warm water and dry in the air (not in the sun). Silk, satin, etc.: Dissolve 40 parts of borax and 10 parts of soap in 70 parts of dilute alcohol and 30 parts of ether, add the yolks of 2 eggs and 10 parts of carbonate of magnesia. Apply this to the spots, wash in luke-warm water, rinse in cold water and dry at moderate heat. For pressing, use only a moderately warm iron. Wine, beer, punch, and similar spots: Wash in clear water. Sugar, gelatine, mucus, glue, blood, and similar spots: Wash out in clear soft water.

SCIENCE NOTES.

The United States Forest Service announces that 150,000,000 acres of forest land in British Columbia have been placed in reserve by the Canadian government. This includes every acre of timber lands of the Province except what has already been leased. The action was taken to check wasteful exploitation of timber resources, and to bring the care and cutting of timber more effectually under government control.

In botany, attention is being more and more directed to the study of plant physiology, with its chemical and physical problems. It is not enough to know that some species of fungi, for example, become black at a certain stage of their growth, but we need the explanation of the cause. The enzyme is to be detected and isolated, and the substance or substances upon which it acts identified. So, too, the many phenomena connected with the growth, nutrition and pathology of plants interest us, but knowledge of what is actually occurring can be had only by application of chemical methods. Systemic study of plants and animals will always be important, but if we are to have adequate explanation of the hundred and one phenomena characteristic of living forms we must turn our attention to experimental methods, as is being so largely done at the present time throughout the biological world, with due regard also to possible chemical transformations and reactions, that may be symbolical of broader changes in function and structure.

Consul William Bardel, of Bamberg, advises that about forty artificial precious stones were recently submitted to the Museum of Natural History at Berlin by an association which claimed to have made these stones, based on the process which recently created so much attention. Several official experts, among whom was the professor having knowledge of gems in the Museum of Natural History, two practical experts, and the chief master of the gold and silver smiths' guild of Germany, were requested to make a careful examination of the merits of the "so-called" new discoveries. The report submitted by this committee of experts reads as follows:

"Of the variety of stones we examined we were favorably impressed only by the artificial rubies. Among these were some of great beauty and worthy of consideration. The white sapphires were of no account at all; they appeared dull and washed out. Well imitated were the yellow precious stones; they really resembled the topaz very closely; but this invention carries with it only very little value, since the real topaz is found in such large quantities that they sell at from 2 to 3 marks (47.6 to 71.4 cents) a gramme. Therefore it would seem of little importance to imitate such common stones. Of all the stones we examined, we can only call the artificial rubies a direct success; but the imitation of this latter species of precious stones is no new invention. We therefore declare that there is nothing new or sensational in the claimed invention."

TABLE OF CONTENTS.

ponge
read
press

goods
ntity
a tea-
ponge
water,
il, 40
parts
yolks
oiling
n the
ve 40
rts of
lks of
Apply
nse in
essing,
punch,
y, gela-
sh out

es that
lumbia
govern-
of the
l. The
tion of
tting of
trol.

direct-
hemical
ow that
lack at
the ex-
detected
es upon
enomena
ology of
actually
chemical
nals will
adequate
na char-
attention
ely done
al world,
nsforma-
broader

ises that
ntly sub-
at Berlin
ade these
y created
s, among
gems in
l experts,
r smiths'
a careful
new dis-
committee

were fav-
s. Among
ay of con-
o account
Well imi-
really re-
invention
the real
they sell
a gramme.
to imitate
examined,
t success;
f precious
eclare that
he claimed